

# MATCOM

- STORAGE

a learning element for staff of agricultural cooperatives

international labour office, geneva

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**MATCOM**  
**Material and techniques for cooperatives management training**

The MATCOM Project was launched in 1978 by the International Labour Office, with the financial support of Sweden. In its third phase (1984-1986) MATCOM is financed by Denmark, Finland and Norway.

In collaboration with cooperative organizations and training institutes in all regions of the world, MATCOM designs and produces material for the training of managers of cooperatives and assists in the preparation of adapted versions for use in various countries. MATCOM also provides support for improving the methodology of cooperative training and for the training of trainers.

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# STORAGE

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## HOW TO LEARN

- Study the Element carefully.
- Write down answers to all the questions in the Element. This will not only help you learn, but also help you apply the knowledge in your work later on.
- After studying the Element on your own discuss it with your instructor and your colleagues, then take part in practical exercises organised by your instructor.

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# INTRODUCTION

## Why store?

Most agricultural co-operatives arrange to store at least some of the produce delivered by their members. This is done for several reasons.

## For example:

- A co-operative may have to hold the small amounts of produce received from individual members until there is enough to make transportation to a processing plant or a bulk buyer worthwhile.
- A co-operative may choose to store the produce until it can fetch a better price on the market.
- A co-operative may need to arrange suitable storage to allow further drying of the produce in order to meet standards set by a marketing board or processors.

If a co-operative is unable to store produce, the members may have to do so themselves without proper facilities, or else sell immediately at unfavourable prices.

Obviously, storage organised by their co-operative may benefit members. But there are many costs and risks involved. You, as the manager or committee member responsible, must know how to store produce safely. You must learn what the risks are and how to minimise them, and how to control the costs of storage so that the benefits outweigh them.

## Types of storage

A co-operative manager usually has two methods of storing produce: in bags or in bulk (in loose heaps, small bins or other containers).

In general, bag storage is more suitable for small-scale co-operatives with short storage periods and limited quantities (the produce of only a few members). Bulk storage is more suitable for long storage periods and larger quantities. Temporary bulk storage may also be convenient for small quantities waiting to be bagged-up, so long as they are not allowed to wait unnecessarily.

Not all co-operatives have special buildings for storage. However, they may still be able to provide successful storage facilities in the open or under temporary roofs.

Bag storage in buildings is the most common method used in smaller co-operatives; we will often refer to this storage method when discussing various aspects of storage in this booklet.

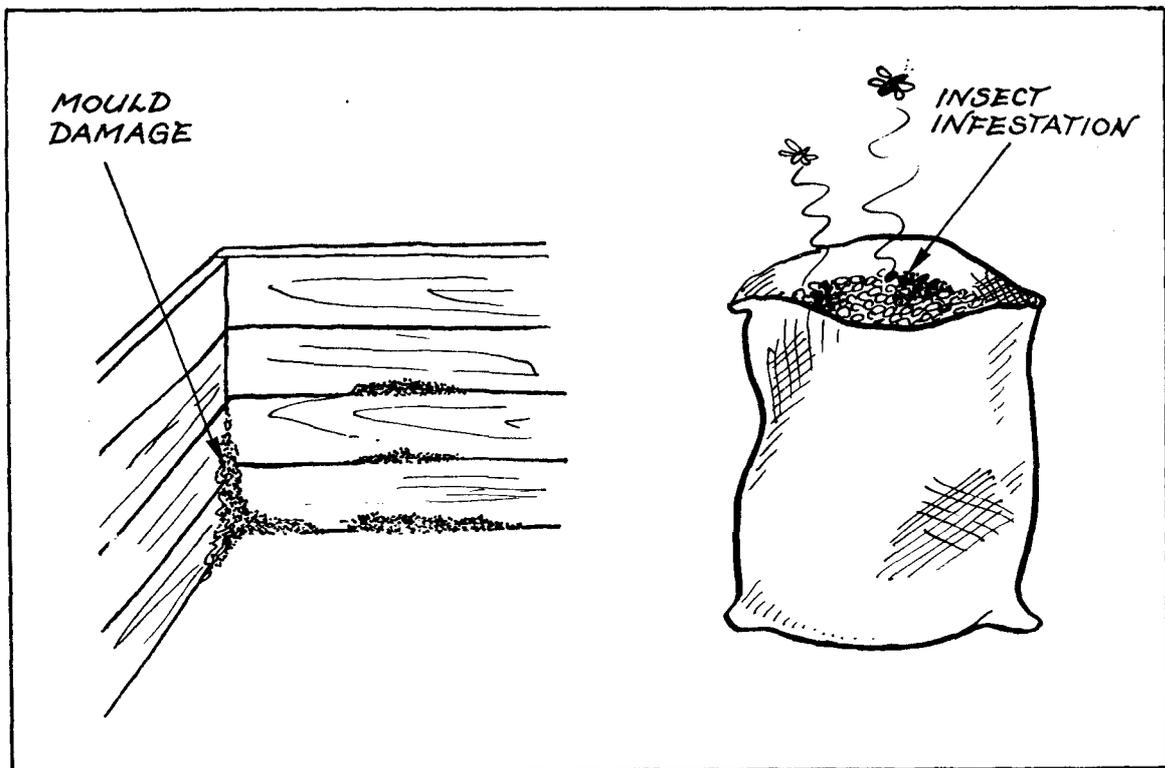


FIG.1A PROBLEMS CAN ARISE WITH BULK OR BAG STORAGE

### Risks of storage

Many factors can negatively affect stored commodities leading to loss of quality or loss of quantity. Some goods - perishable commodities - cannot be kept without loss of quality for more than a few days unless specially treated. Others - durable commodities - can be kept for extended periods with little loss of quality if stored in good condition with protection against pests. Many agricultural products, especially crop seeds such as food grains, are durable in this way.

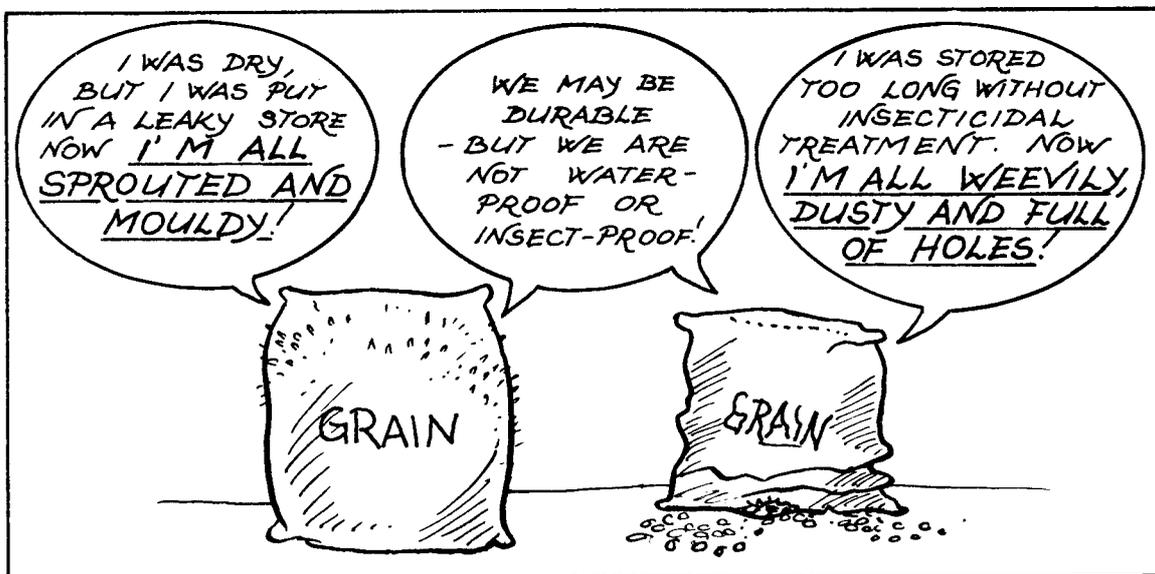


FIG.1B DURABLE CROPS NEED PROTECTION AGAINST MOISTURE AND PESTS

Regardless of durability, commodity safety still depends on the storage situation and the way it is managed. While rotting of perishable commodities is the most obvious, several other types of loss may occur -

- loss of weight due to "shrinkage";
- spoilage due to moulds;
- loss of quality and quantity due to pests;
- loss of quantity due to spillage and pilferage.

If you are responsible for storage you will need to understand all of these - and the fact that usually such losses, in one way or another, are caused by poor storage management .

- If a storekeeper keeps perishable goods too long without the necessary special arrangements, it will be his fault if they rot.
- If he takes a durable **product** - like grain - and stores it when it is inadequately dried its loss will be his fault. There are moisture problems - shrinkage or mould damage.
- If he puts good dry grain into storage but does not protect it against pests (rats, insects, birds), spillage or pilferage (theft), it will be his fault if it is lost or contaminated.

In the following pages we will examine these problems in greater detail.

# MOISTURE PROBLEMS

## Moisture content

All agricultural products contain some water (moisture). In most crops the moisture content is high at maturity but then falls quite quickly (if the weather is dry) up to harvest time. This natural drying continues after harvesting if the crop is exposed to dry air. It is the dryness of the air and air movement that are most beneficial to drying. Sunshine helps by warming the air or the crop if it is exposed to the sun. These natural effects can increase the rate of drying. In humid climates, on the other hand, dry produce may reabsorb moisture.

## Shrinkage

Even when crops are considered sufficiently dry for safe storage there is some moisture present. If the climate is very dry, or if the crops were not well-dried before storage, drying-out may continue in the store.

Produce that continues to dry in a well-ventilated storage area will not deteriorate although it will lose moisture and weight. This is what we mean by shrinkage. Shrinkage can only be prevented by ensuring that the produce is sufficiently dry before it is placed in storage.

## Mould

Most agricultural products have organisms living on them - such as various types of moulds - which are, themselves, plants. These organisms remain dormant if the produce is dry. If it is not sufficiently dry, however, they begin to grow and produce both heat and moisture. Agricultural products not dry enough to avoid this mould growth must not be stored in large bulks or bag-stacks where air cannot freely circulate. The trapped moisture creates a high risk of severe damage due to mould growth and "heating".

The basic problem

Most farmers know that produce must be dry before it can be safely stored - but they would be quite happy to sell their crops at high moisture content and have someone else accept responsibility for storage. The crops would weigh more and the problems of drying, shrinkage and spoilage would fall to someone else.

It is often possible for farmers to dry their produce properly before delivery to a co-operative or other collecting centre. Therefore, you should avoid burdening your co-operative with shrinkage and spoilage losses by accepting insufficiently dry produce.



FIG.2 DO NOT ACCEPT UNDER-DRIED PRODUCE IF THE FARMER CAN DRY IT HIMSELF

In very humid climates or occasional bad weather it may nonetheless be necessary, and helpful to your members, to accept insufficiently dry produce. If you are prepared to dry such produce for them at least make sure that you do not pay for the excess moisture that will be lost during drying.

The essential points for good storage management however remain the same in all cases and all circumstances:

- You must know whether or not the produce is dry enough at the time you accept it for storage.
- You should not accept insufficiently dried produce unless steps can be taken to deal with it before or during storage to prevent spoilage by mould and to take into account shrinkage losses that may occur.

Testing for dryness without a moisture meter

We said that it is important to check the dryness of the produce at the time of intake. How can this be done?



FIG.3 EVEN WITHOUT A MOISTURE METER YOU CAN TEST FOR DRYNESS

It is possible to judge the dryness of most agricultural products by "feel", using simple rough-and-ready methods. Experienced managers often test grains, pulses and oilseeds by cracking them in their teeth, or pushing an arm into the bag to see how deep it will go. Other produce, like ginger or copra, they can snap in their fingers to test for clean breakage and a dry sound. Large roots and tubers they feel and weigh in their hands: knowing, for example, how heavy a good yam should be according to its size.

Although they are able to guard against mould damage in storage and against too much "shrinkage" this way they cannot measure shrinkage losses because these methods are not sufficiently accurate.

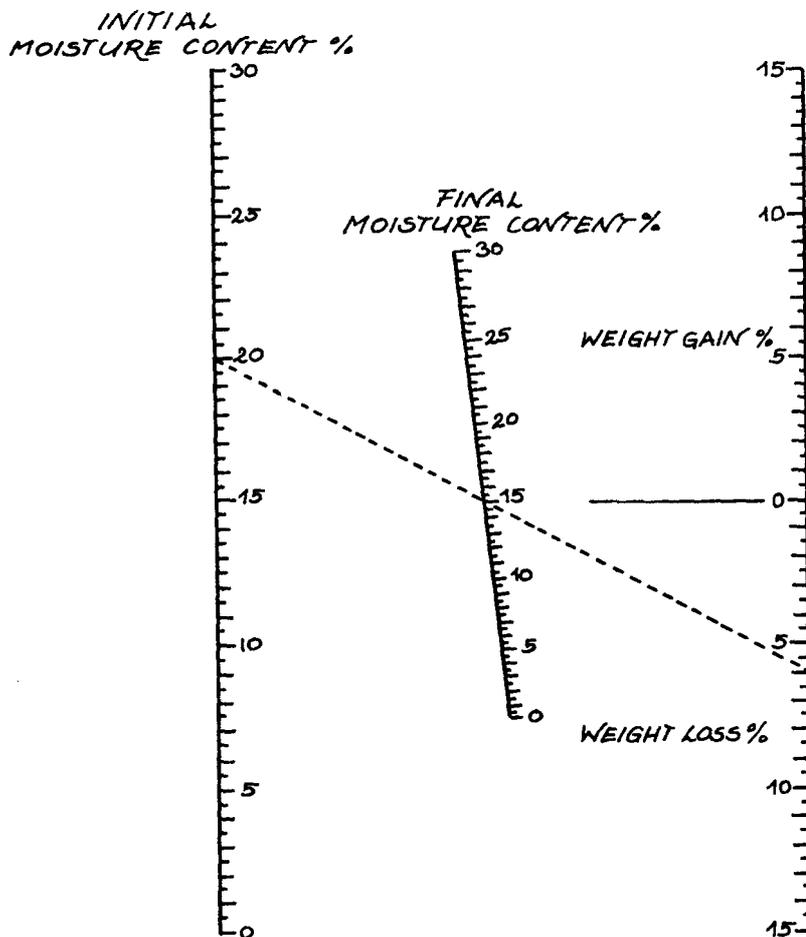
You should also try and find ways to learn these "feel-methods". Some of them require a lot of experience, but through practice you should be able to acquire some of the necessary skill.

Testing for dryness with a moisture meter

Testing for dryness can be done more accurately by using a moisture meter. It will enable you to measure moisture con-

tent both when you receive produce and when you discharge or sell it from your store. You can then calculate the weight changes that are due to loss (or gain) of moisture while in storage.

There are many types of moisture meters available on the market. Most of these give reasonably reliable results if the manufacturer's instructions are carefully followed. Meters with unclear instructions, or none at all, are unlikely to prove reliable in use.



SOURCE: JAMIESON, MFS (1970)  
TROPICAL STORED PRODUCTS INFORMATION, No. 20, pp. 19-20

FIG. 4 HOW TO RELATE CHANGE IN MOISTURE CONTENT TO CHANGE IN WEIGHT

You should be aware of the fact that most moisture meters are designed for a specific type of produce. Therefore, there is no point using a moisture meter that only has a scale for maize, for instance, if you are dealing with wheat

or rice. Some meters, however, do have scales for different kinds of grain and even other kinds of produce (pulses, oilseeds, cocoa and coffee beans).

If a moisture meter is necessary for your co-operative, then the type chosen must be acceptable to your produce buyers. Make sure you get their advice. It must also be acceptable to the farmers from whom you buy if they are to be paid according to moisture content. You will need to demonstrate the method and show that it is fair and reliable to all concerned.

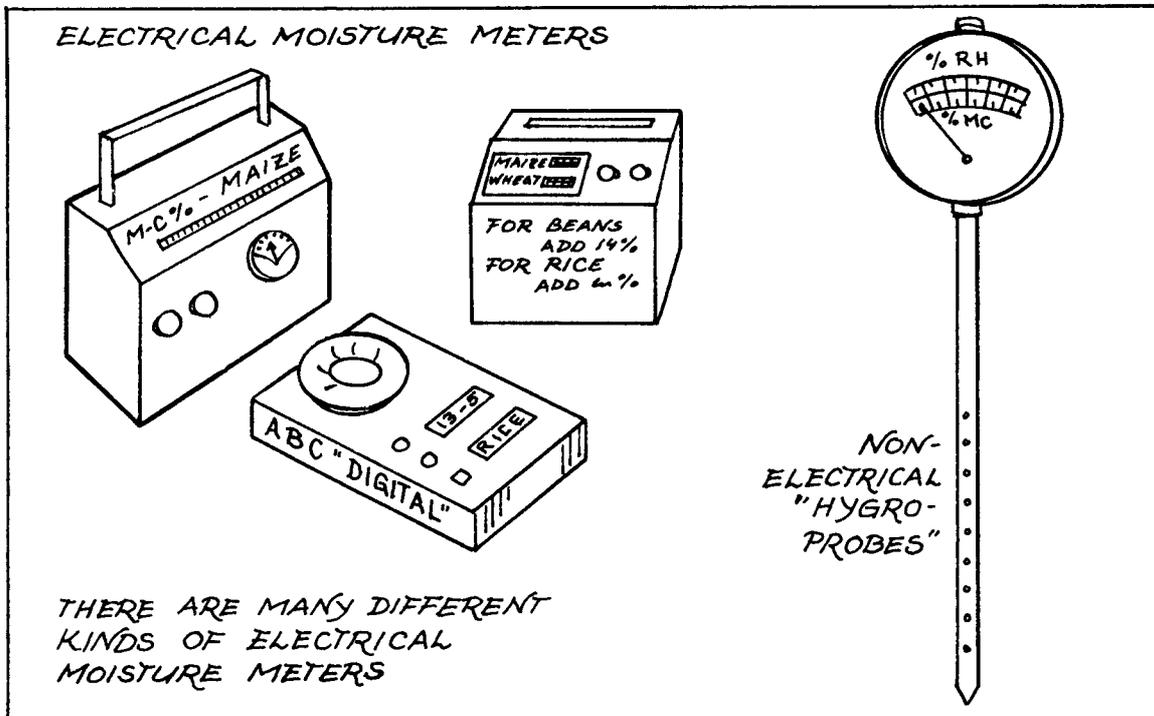


FIG. 5 MOISTURE METERS

Percentage moisture content

The amount of moisture in a commodity is usually referred to as a percentage by weight: most commonly as a percentage of the total "wet" weight. For example: grains containing 15 g of detectable moisture in every 100 g of the grain sample would have a moisture content of 15 % (wet basis).

What is meant by "safe" percentage moisture content?

The percentage moisture content corresponding to a particular degree of dryness is not the same for all produce. Therefore, the moisture content that is "safe" for storage differs between commodities.

For instance, well-dried maize grains have a moisture content of 12 - 13% on the wet weight basis. For paddy, it is about 15%; for well-dried groundnuts in the shell, about 8%.

What is the "safe" percentage for your produce? You have to get that information from your buyer or from the agricultural or co-operative advisers in your region.

How do you deal with produce that is not sufficiently dry?

If it is necessary to accept under-dried produce special arrangements will have to be made for further drying.

If the produce is almost dry enough, however, it may be sufficient to allow further natural drying by open stacking in the store.

otherwise, additional sun-drying or forced aeration in a mechanical dryer is needed. Remember that produce can also lose quality if it is dried too much or too quickly. Grains for example can be cracked by rapid drying.

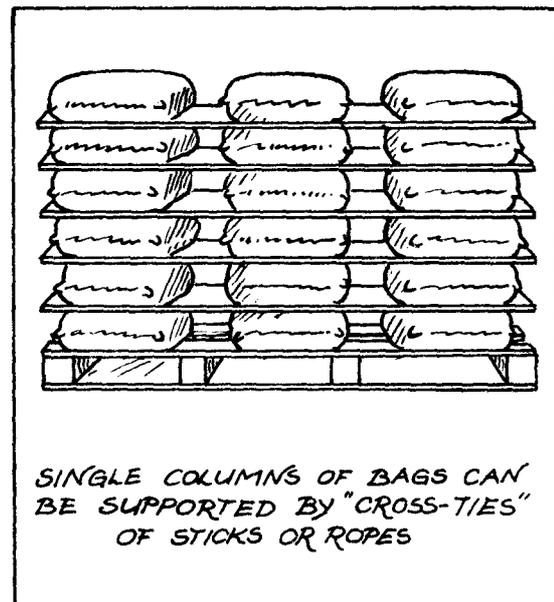


FIG. 6 OPEN STACKING PERMITS DRYING IN STORE

Note: If the grain being dried is too hot to hold comfortably in the hand, it is too hot for safety!

### Controlling moisture and temperature in storage

Even if produce is properly dried before storage, moist air or water can increase its moisture content. Even if the produce is reasonably cool when stored a store that is badly designed over-loaded or unventilated can build up heat which in turn can cause infestation.

There is a direct relationship between temperature and moisture; warm air can hold more moisture than cool air. This may assist the drying of produce but if the commodity itself is made warmer it encourages infestation and decay.

Excess moisture and high temperature are the two main enemies of stored produce. They must be controlled by good store design and by adequate ventilation.

Actual wetting (caused by rain through a leaking roof, a wet floor, wet bags, condensation in the building, etc.) will of course, be even more damaging. Its prevention depends upon good store management including maintenance of the storage structure.

### Accounting for shrinkage

Although shrinkage loss during storage is unlikely to be more than 1 - 2% it will still have to be considered if the product is bought and sold by weight. How do you allow for this shrinkage.

With the experience of several seasons storage, you may be able to detect that a certain shrinkage loss, on average, is normal for a particular product. You may have to demonstrate to the members of your co-operative that this is so.

If necessary, arrange a public weighing demonstration at intake, and again at discharge, of specially marked bags. (Use a seal on the stitching.) This will show how much weight is lost in storage due to shrinkage, provided that you can

ensure that no damage occurred due to pests, spillage and theft, or show that you have taken such other losses into account.

If you can establish that shrinkage occurs when you have to accept produce that is not quite dry, as long as it is in otherwise good condition, you should accept it only at a discount. If, for example, the produce loses 1% of its weight in storage due to moisture loss your payment at intake should reflect that and should be discounted by that amount.

If you have a reliable moisture meter, so that you can measure moisture content at intake and discharge, you can calculate the loss of weight due to shrinkage on that basis.

#### Inspecting for mould

As we pointed out earlier moulds are very small plants. They can grow on many different materials, particularly under moist conditions. They usually appear as grey, green or blackish discolouration on produce or containers. Look for them.

Such discolouration can lead to costly down-grading of produce. More extensive mould damage can completely destroy grain so that it crumbles if rubbed between the fingers. Some moulds also produce poisonous substances, especially dangerous in foodstuff, that may cause illness or death in humans, poultry and livestock.

Well-dried produce, protected from wetting, will not suffer serious mould damage unless insect infestation (producing the heat and moisture which foster mould growth) is allowed to develop.

If you see mould developing on only a single kind of produce in your store, it is a sure sign that the moisture content of that produce is too high. If it is very localised, es-

pecially on the surface of a stack, it may also indicate a leaky roof! Roof leaks may even cause grain to sprout!

#### How do you deal with mould?

The only remedy is to reduce the moisture content of the produce. This can be done by further sun-drying outdoors, by increased ventilation when the air outside the store is dry, or by artificial drying if you have the equipment for it. The only other alternative is to sell the produce as quickly as possible.

If moulds grow more generally all over the exposed surfaces of different lots of produce, then it may mean that the humidity throughout the store is too high. It must be reduced by ventilation as soon as possible. Open all doors, windows and ventilators whenever outside conditions are favourable. BUT REMEMBER: VENTILATION IN WET WEATHER WILL ONLY INCREASE MOISTURE CONTENT!

## Precautions: moisture-proofing

- 1) Keep the storehouse physically dry at all times.

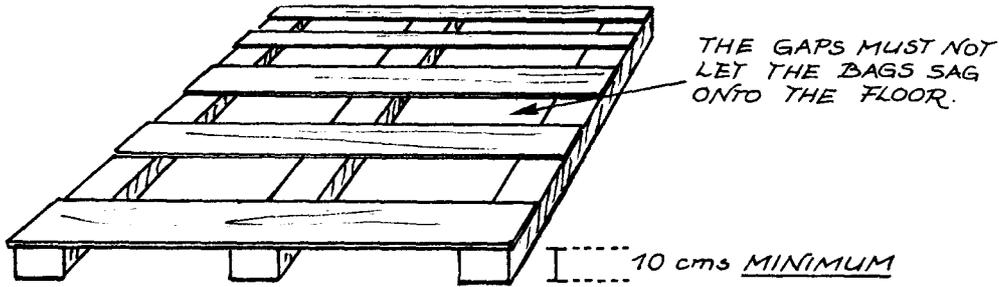
This requires an effective programme of inspection. Look for wet patches and find the source of any water damage immediately.

- 2) Arrange proper ventilation.

Extensive ventilation will facilitate drying in a dry climate, but may increase moisture content in a wet one.

- 3) Keep a watch on storage conditions.

If you have a moisture meter make regular tests of produce moisture content in at least the surface bags. If you have a thermometer check the air temperature and the temperature of stored produce. Otherwise, use your own senses.



*MAKE THEM TO A PLAN SIZE CONVENIENT FOR HANDLING AND TO HOLD NEATLY AT LEAST ONE STACKING UNIT OF BAGS OR BOXES.*

FIG.7 A WOODEN STACKING PLATFORM OR "PALLET"

- 4) Never place produce directly on the floor.

Concrete floors may not be moisture-proof and dampness may rise through them. If platforms are not available use wooden stacking platforms (pallets) or waterproof paper or plastic sheets (dunnage).

## PESTS AND PEST CONTROL

Are rats and mice in your store something you must learn to live with? Are all those weevils really doing any harm? Those sparrows and pigeons in the roof - they always seem to come in. They make a mess but is it worth trying to stop them?

Are pests just a nuisance or are they eating away the society's profits?

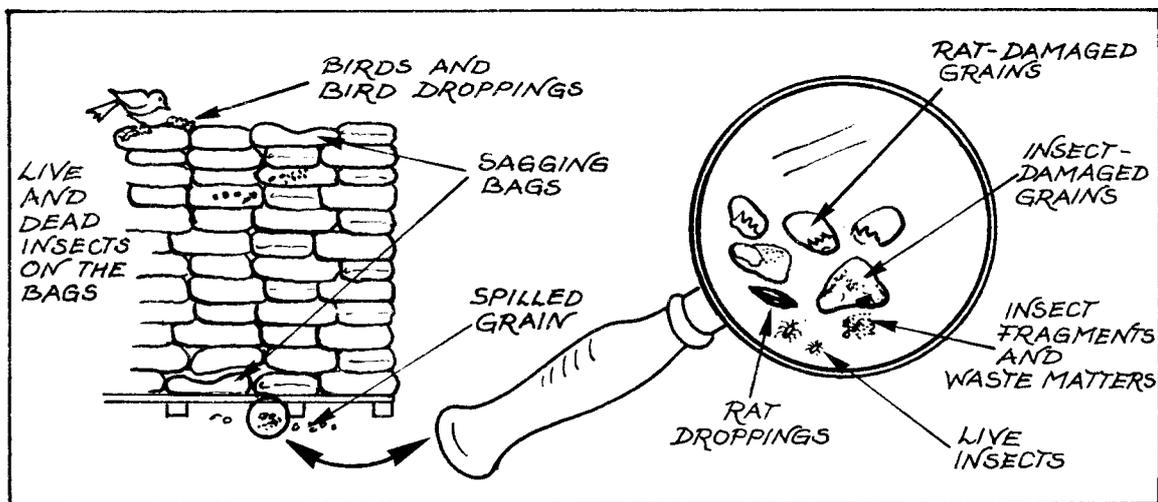


FIG. 8 PEST DAMAGE CAUSES OBVIOUS TROUBLE; IT ALSO CAUSES MUCH MORE TROUBLE THAT IS LESS OBVIOUS

If you have been in the business for some time, you know that it is almost impossible to keep a produce store completely free of insects and other pests. But, have you ever tried to calculate the cost of feeding these pests and cleaning up after them... not to mention the cost of repairs to torn bags and rat holes? If you work it out you may be surprised!

It is always important to keep pest infestation down by good hygiene in the store. If you have to store produce for more than a month or two extra precautions and additional measures to control infestation are likely to be necessary. If you have calculated your losses you will be better able to decide how much might have to be spent on control measures to reduce the losses.

If you want your members to have confidence in your ability to handle their products and seed grain you cannot afford to ignore pests. How do you tackle the problem of infestation?

Rodents

Rodents - rats or mice - in your store eat your produce and contaminate it with their droppings, urine and hair. They are a public health risk in addition to being very destructive. They are known to carry several serious diseases. They damage sacks and other containers in their efforts to get at the contents and attack a wide range of products. Just the spillage from containers they damage makes extra work for storekeepers and increases both the risk of contamination and your losses.

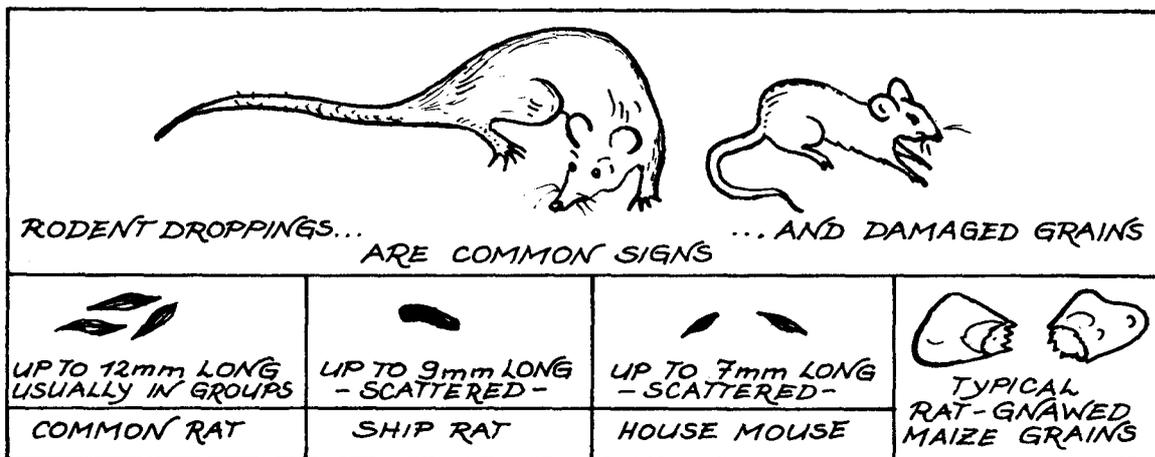


FIG. 9 RATS AND MICE CAUSE DAMAGE AND SPREAD DISEASE

The damage and loss caused by rodents increases in proportion to their number. They multiply very fast - a store infested by 8 rats (four male, four female) can have a total population of 1,000 rats at the end of a three-month period!

Although it may be useful to remember that an average rat will eat about ten kg of grain a year and a mouse one to two kg, estimating the number of rodents in a store and how much they "consume" is very difficult.

More serious than the amount they consume is the damage they cause by contamination and the spillage resulting from gnawed containers. The latter, at least, can be easily recorded and measured.

### Insects

In tropical climates, insects are often the major cause of storage loss. They can damage and contaminate produce, eat a considerable quantity, produce heat and foster mould growth.

Some insects actually feed and develop inside individual grains, leaving a distinct hole when they emerge. Others (like warehouse moth larvae) feed on broken grain or the germ of cereal grains. They can seriously reduce the quality - as well as the protein and vitamin content - of cereals and the germinative power of seed grain.

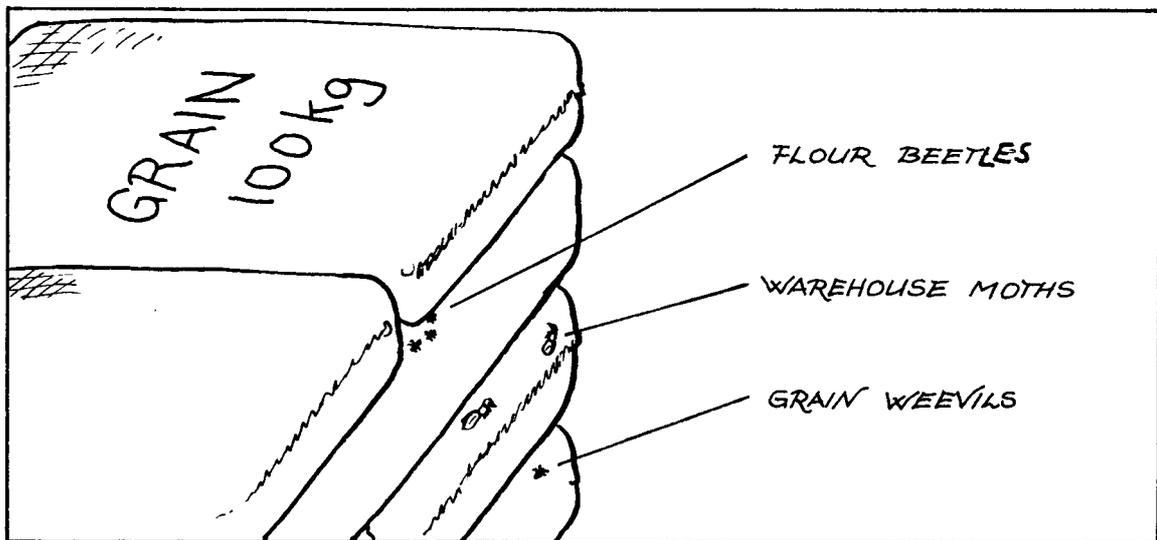


FIG. 10 INSECT PESTS IN STORES ARE VERY SMALL BUT INCREASE IN NUMBER VERY QUICKLY.

Many insects, especially moths, have larvae that bind grain together in lumps, causing evident spoilage.

For various reasons, signs of insect infestation in foodstuff and other produce may make it unacceptable to buyers and may cause a costly down-grading of its market value. Buyers do not want to spend money on expensive disinfestation treatment. In addition their final markets may not permit any sign of insects in foodstuff.

While a single insect may eat very little, like rodents they multiply rapidly. In total, they eat a lot!

You may get some idea of your loss due to insect pests if you compare samples of damaged and undamaged grain which is otherwise equal in volume, dryness and other characteristics. Weigh them. The difference reveals some of the loss. Suppose, for instance, that the damaged sample weighs 46 kg and the undamaged 50 kg. Your loss is 4 kg out of 50 kg, or 8 out of 100, which means there is an 8% weight loss due to insect infestation. Although you paid a farmer for the 100 kg, when you sell it you get payment for only 92 kg. The value per kg may be reduced further by down-grading due to its condition. Who pays for the loss? You do.

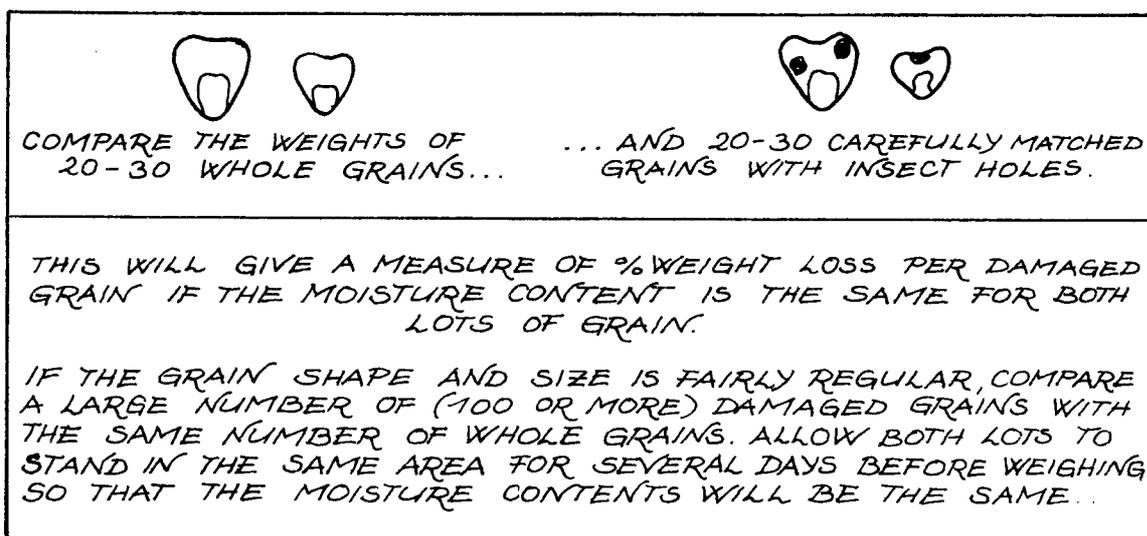


FIG. 11 WEIGHT LOSS DUE TO INSECT DAMAGE

You can also make a rough estimate of weight loss due to infestation by visual inspection of grain. A weevil hole in each maize grain, for example, means a weight loss of about 10%. In wheat grains it is about 30% and in milled rice grains about 75%. These are very rough figures but they help us understand the relationship between percentage grain damage and percentage loss.

For example: maize with 10% weevil-damaged grains would show at least 1% weight loss. Wheat with the same percentage of weevil-damaged grains would show about 3% loss. What would be the loss in milled rice with the same percentage damage?

### Birds

Birds are usually less of a problem in stores than on standing crops or grain-drying floors but they can also damage bags and cause spillage (sometimes so much that stacks collapse). They contaminate stored produce and grains with their droppings, feathers and even their dead bodies. Some can also be responsible for the spread of disease. All create a nuisance and unhygienic conditions in warehouses if not kept out!

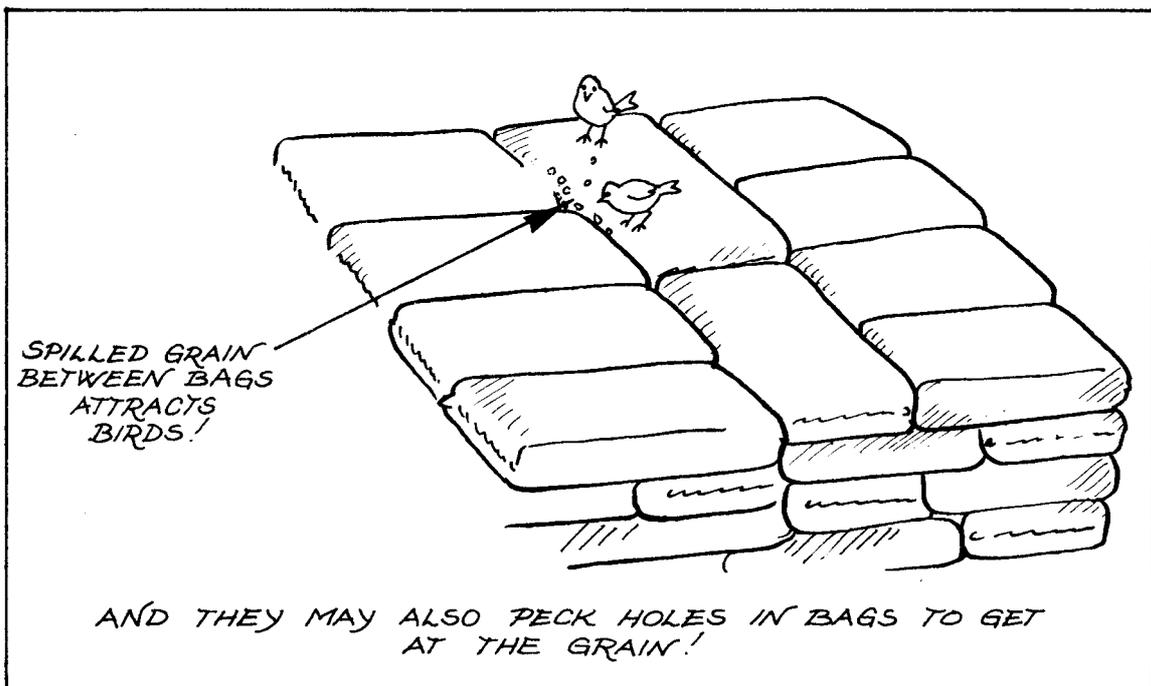


FIG. 12 BIRDS WILL PERCH AND NEST IN YOUR STORE IF YOU LET THEM IN!

## Precautions: pest-proofing

Your first action to guard against pest infestation is prevention. Pest-proofing your store should be done before any other control methods are used. Prevention in the long run, is cheaper and more effective. It is fairly easy to keep out rats and birds if your buildings are well built and have strong walls. It is harder to keep out mice; and few stores can be made completely insect-proof.

### Keeping out rodents

Rats and mice usually enter a store at night through gaps under and around doors and door frames, through ventilators, broken windows, cracks in the walls, holes in the roof, spaces under the eaves, around pipes and cables that enter the building.

Remember that rats and mice can both jump and climb. All openings, even high up the walls, may become regular doorways for rodents.

All of these entry points can usually be sealed or screened to keep rats from getting in. Mice are more difficult to keep out because of their smaller size and because they are more often carried into a store in bags of produce.

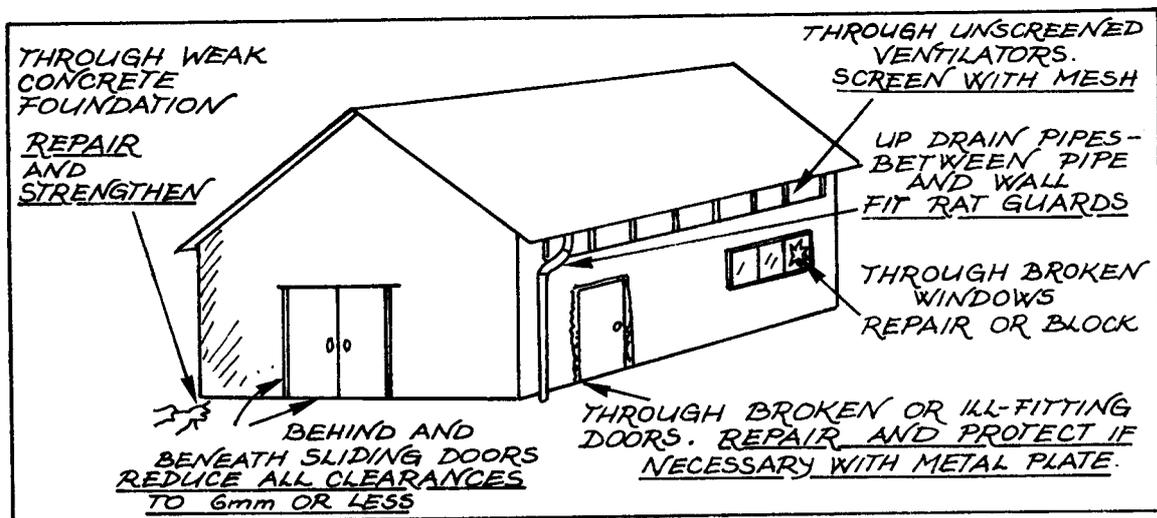


FIG. 13A ENTRY POINTS FOR RODENTS

Wooden doors and door frames should have metal plates, 300 mm deep, fitted at the bottom to prevent rats from gnawing holes. Strong wire mesh screens, with holes not bigger than a pencil diameter (6 mm), should be fitted to ventilators. Unnecessary gaps where walls meet the roof should be sealed with concrete or cement mortar reinforced with wire mesh or broken glass. (See pages 32 - 33 for control measures.)

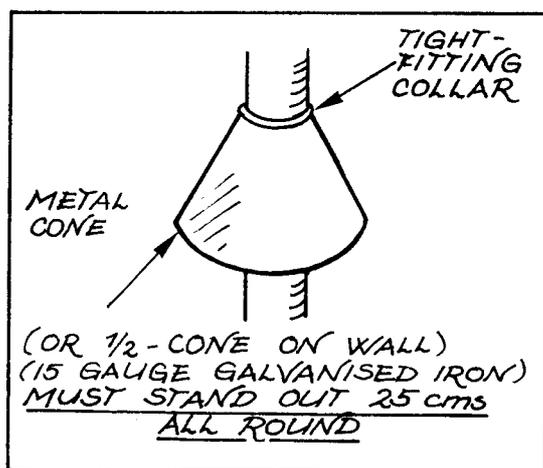


FIG. 13B RAT GUARDS FOR PIPES AND CABLES

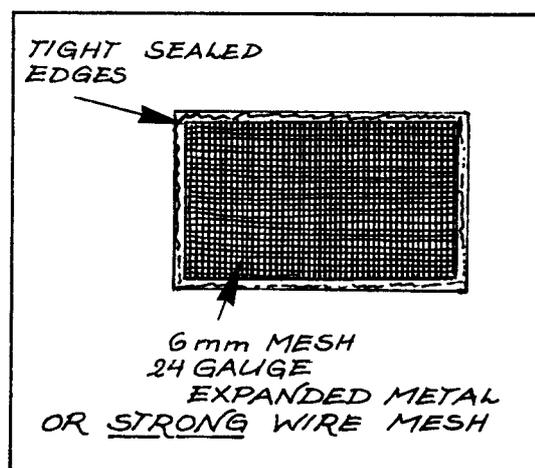


FIG. 13C RODENT SCREENING

#### Keeping out insects

It may be possible to keep the larger insects out of a store by fitting mosquito netting to ventilators and by closing all doors early in the evening ... before insects begin to take flight. Some insects, however, are small enough to get through mosquito netting, others fly in as soon as doors are opened and still others (like weevils and grain moths) enter as eggs or grubs (larvae) inside the grain. In general, insect-proofing is almost impossible. Other control methods must be used. (See pages 28 - 32.)

### Keeping out birds

Birds often gain entry into a store in ways similar to that of rodents - through broken windows, open ventilators, under eaves, under badly fitting roof sheets, or through open doorways.

Screens that are good enough to keep out rats and mice will also keep birds out. Make sure that the store doors are only left open when goods are moving in and out or when rapid ventilation is needed. Any high level openings that cannot be reached by rodents can be screened against most birds by carefully fitted strong wire or string netting, with 2 cm square mesh.

### **Precautions: store hygiene and inspection**

It should be obvious that you have to do everything possible **to** prevent pests from entering your store. But you will probably never be completely successful in this. Therefore you must always be on the look-out for signs of pests. Once you discover an infestation you must know what control methods are most effective and take action immediately... before the problem gets worse.

Two prints are extremely important:

- 1) Good store hygiene - tidiness and frequent cleaning - is basic. If your store is untidy and dirty any other treatment will be a waste of time and money.
- 2) Since early warning of infestation is needed to avoid serious losses, you must carry out regular and thorough inspections. (These, like other measures, will be easier if your store is clean and tidy.)

#### Store hygiene

- Arrange all goods and stacking of bags (see pages 54-55) in a way that facilitates all work, including cleaning.
- Keep the inside of the store neat. All working areas and gangways where spillage collects should be swept clean at the end of every working day.
- When the store is empty, or when space permits, all wall-- and roof trusses should be swept down. Cracks in the floor or walls should be cleaned out and, if possible, repaired.
- When a stack is broken down the stacking platforms or other dunnage should be lifted, taken outside and swept down. The floor space it occupied should also be cleaned.
- Spillage that can be saved should be collected separately, re-bagged and labelled. Spillage that may have become contaminated by insecticides should be labelled as such until its proved safe for use. These bags in particular should then be inspected regularly for signs of infestation. Dirty sweepings should be burned, not just thrown outside.

- Keep the area outside your store clean and free from weeds, store spillage and rubbish.
- Do not allow crops to be grown close to store walls. Rats and mice are encouraged by anything that provides cover for their movements.
- Do not allow dumping of old sacks, broken pallets, rusty drums, or other rubbish outside the store. Such items harbour rats.
- Do not allow your store to become overloaded with re-bagged spillage awaiting tests for wholesomeness. IF YOUR LOCAL ADVISERS CANNOT DECIDE ON THIS, THE SUSPECT GRAIN SHOULD BE REMOVED ELSEWHERE, DESTROYED OR SAFELY DUMPED.

### Inspection

Rodents what\_should\_you\_look\_for?

Rats and mice are not usually seen in the store in the day-time unless they are present in large numbers. You must look for signs of their presence and activity.

Entry holes, new spillage from torn bags, droppings on the floor around the walls (and particularly in the corners), pieces of torn sacking, and partly eaten grain on bags or on the floor are all signs of rats and mice. Use a flashlight to inspect dark places.

Figure 8 on page 17 shows some of the tell-tale signs to look for!

Insects---what-should-you-look-for?

If you find - without actually searching - live or dead insects on or around the stacks and a whitish dust on the bags, then the infestation is already heavy and considerable damage will have been done. A heavy moth infestation may cause hanging strands of "silk", insect droppings webbed together and even extensive sheets of silk webbing on the bags. You will also see insects flying above and around the infested stacks, especially in the late afternoon when they are most active.

Your job, however, is to locate the signs of infestation before this stage - before the damage is serious. Therefore, frequent, regular and careful inspection is necessary.

Examine bags closely for signs of insects. Lift those at the top of the stacks and look beneath them. Look in the ears of the bags and in crevices and corners in the store, especially where grain or other foodstuff has lodged. Check for evidence of heating. Lift a few bags and feel underneath. Noticeable heating means either too much moisture in the produce or a heavy insect infestation deeper in the stack.

Look for the small brown or blackish beetles and the slightly larger grey or brown-and-white warehouse moths that are the most common and troublesome pests.

If you find tiny, papery brown-and-white "shells" - the cast skins of beetle larvae, which periodically shed their outer skin like snakes - then beware! All beetle larvae shed their skins but if you find masses of them in spillage between bags or in cracks in the wall you probably have the Khapra beetle in your store. This is a very destructive insect, which is also very difficult to control and you should obtain advice from your local crop protection services.

If you find large black or dark brown beetles, about half the length of your finger-nail, it probably means that you have old infested food residue somewhere. Look for them and clean them out! Cockroaches are a sign of damp or dirty corners or cracks in the walls. These insects are rarely a problem in clean, dry storage places.

Take samples out of the bags and look for insects in the grain. You will probably not discover any live insects in the grain until the infestation has reached an advanced stage although you may find dead insects and damaged grains earlier.

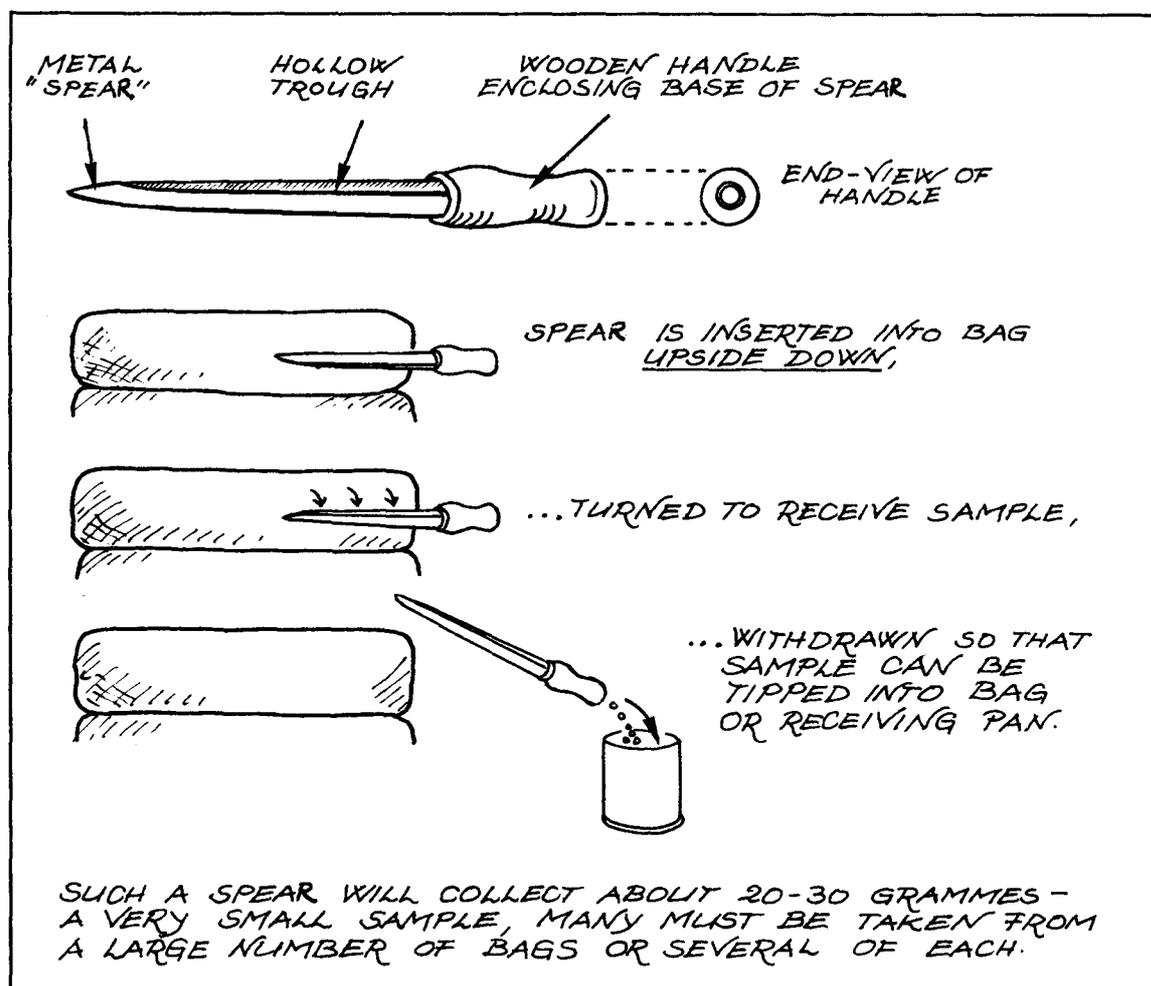


FIG. 14A INSPECTION AIDS: A SIMPLE SAMPLING SPEAR

When you take samples, make sure that they are "representative" (taken from various parts of the stack and the bags) and that you have enough samples. Then count the number of insects per kilogram, and record your findings. If the number of insects is high, or increases between inspections, some action is needed!

When in doubt about what to do ask for assistance or advice from the marketing board, the agricultural department or the co-operative office.

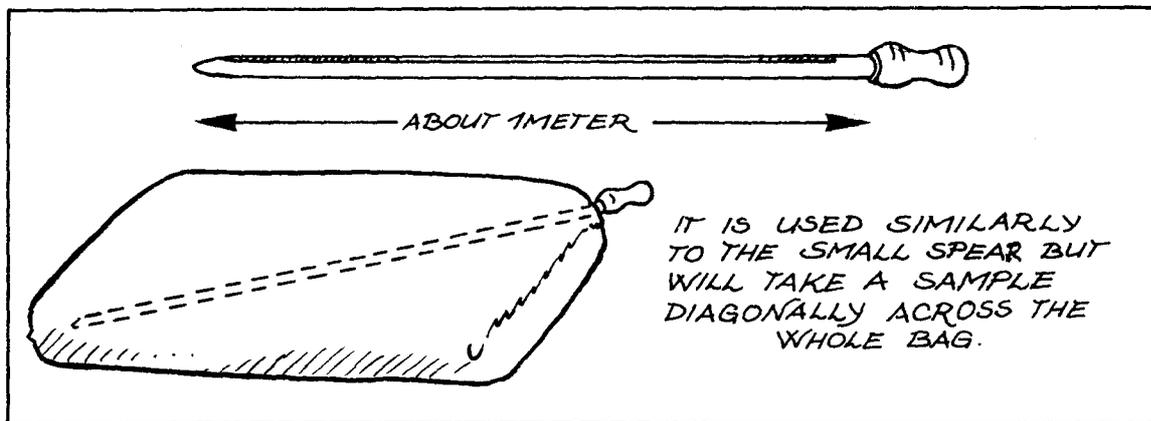


FIG. 14B A LONG SAMPLING SPEAR

Birds - what should you look for?

The presence of birds in stores is usually obvious. If they are not seen, scattered spillage around the bottom of stacks may indicate bird activity on the top. Check for damaged bags, broken windows, torn mesh or gaps at the eaves of the store.

## Precautions: pest control

A heavy pest infestation of your store will mean high losses and increased costs for your co-operative. Control measures, if correctly chosen and applied, are certainly cheaper. It pays, in other words, to take immediate action if your routine inspections reveal a problem.

Much can be achieved by preventive measures but for effective pest control other additional measures may need to be taken. Some of these you may be able to carry out yourself while others call for special skills and expensive equipment.

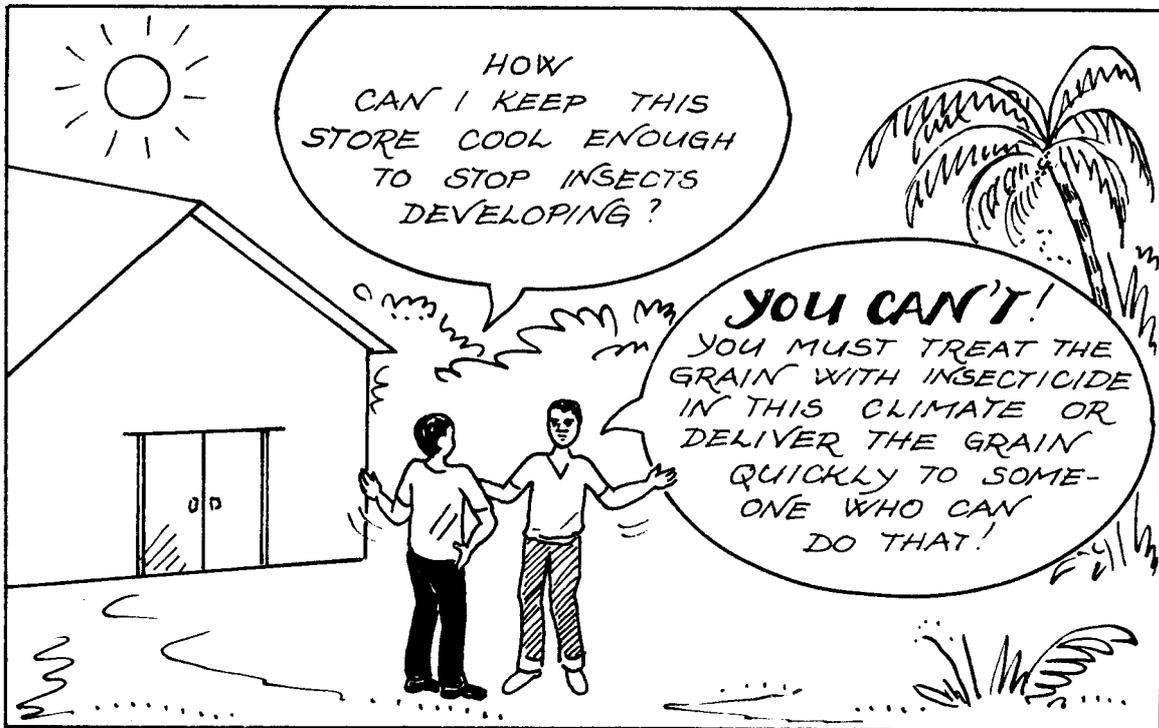


FIG. 15 PEST CONTROL: WHAT CAN YOU DO?

### Rodent control

obviously if rats and mice have found a way into your store you should find the route they take in and out and block it. Check your rodent-proofing. Also, be sure you are not encouraging them by leaving uncovered buckets of water or a dripping tap. They need water as well as food; do not make life easy for them.

## Trapping

Your next task is to catch those rats already inside the store. Trapping is the most common practice.

Use the "break-back" type of trap. It is the most effective. See that you have the right size - rat traps will not catch mice and mouse traps are no used against rats.

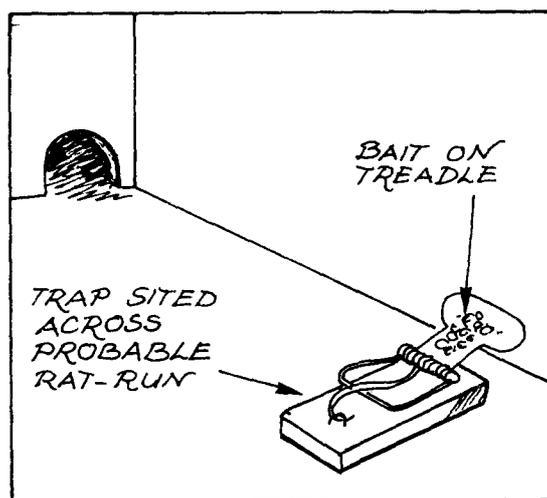


FIG.16 A "TREADLE" OR "BREAK-BACK" RAT TRAP

Place several traps around the store. Put them at the base of walls or stacks and across the runway. Use a sprinkling of grain flour (or soaked grain) to bait the trap for mice. Small pieces of fruit may prove better for rats.

Leave the traps baited but unset for a few nights (this is called "pre-baiting") so that the rats get used to them. Rats are very cautious animals.

Then set all the traps on the same night and in the same place where the rats got used to seeing and feeding from them. **Collect** the traps the next morning, including the unsprung traps, and burn the dead bodies.

Use gloves when handling the traps and the dead rats to avoid disease. Wash your hands afterwards as an extra precaution.

You may not catch all the rats in the first attempt but wait a few days before trying again if you want to get good results. Then repeat the entire operation.

"Pre-baiting" is not necessary for mice. They are much less cautious than rats. But it does no harm and it gives you a chance to see how many of the traps are being visited. If all the bait is gone you probably need several more traps!

### Poisoning

There are many types of rat poison available. Some contain rapid-action poisons like zinc phosphide or arsenic, others contain slow-acting poisons like "warfarin" and other blood-anticoagulants. The latter are safer and easier to use and, in many situations, are more effective.

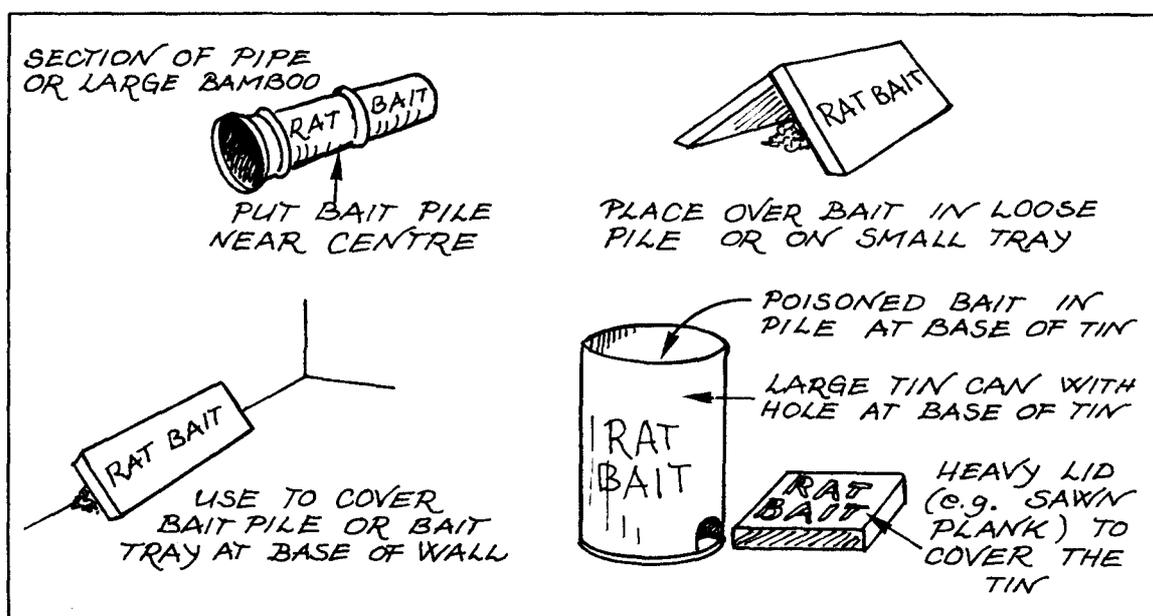


FIG. 17 SOME SIMPLE BAIT COVERS AND CONTAINERS

The manufacturer's instructions must be closely followed. All rat poisons can kill other animals as well as people (the old-fashioned rapid-action types are particularly dangerous).

The whole operation - including storage of the poison, placing of the poisoned bait and collecting and destroying unused bait and dead rats - must be carefully planned and supervised. Special care must be taken so that any and all risk of accidentally poisoning dogs, cats, pigs and other animals is eliminated.

## Insect control

It must be said again: the basis for effective insect-control is good store hygiene. Insects can breed on old spillage in cracks and corners and for this reason frequent sweeping and cleaning-down can greatly reduce infestation.

Other control measures are, however, often necessary. You may for example have to use some kind of insecticide. The most common application methods are the following:

### Spraying

The walls of the store, the inside of doors and the roof frame can be sprayed every 3 to 6 months with an appropriate water-based insecticide, using a suitable spray pump.

*THIS MUST BE PUMPED UP FOR EACH LOT OF SPRAY BUT "PRESSURE-RETAINING" PUMPS ARE MUCH MORE COSTLY AND MORE LIKELY TO DEVELOP FAULTS.*

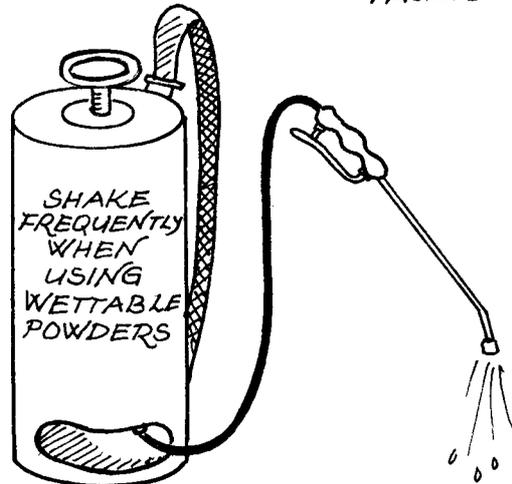


FIG. 18 A PNEUMATIC SPRAY-PUMP

### Dusting, powdering

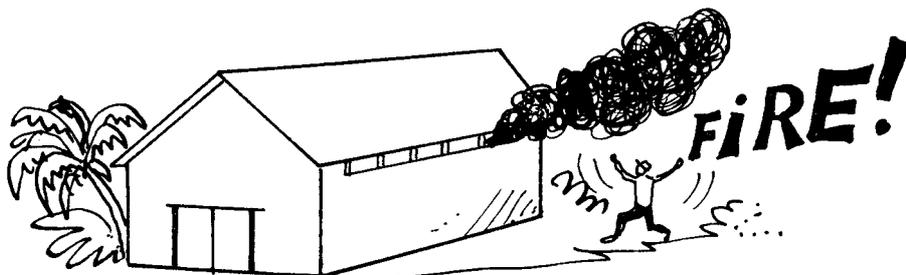
Horizontal surfaces can be treated with a suitable powder insecticide. Overall they are generally less effective than a spray except in treating cracks and cavities in floors.

### "Space treatment"

Frequent treatment of the air-space in the store with an insecticide "fog" or "smoke" can help control flying insects. Special "smoke generators" or large "aerosol dispensers" are used for the application, but they should not be expected to solve all the insect problems

## Fumigation

Disinfestation of grain and other commodities can only be done quickly and completely by fumigation with a suitable poison gas. This is a job for specially trained operators.



"SPACE-TREATMENTS" ARE NOT MUCH USE IN A STORE THAT CANNOT BE WELL SEALED.

"FOGS" AND "SMOKES" ESPECIALLY WILL BILLOW OUT QUICKLY THROUGH ANY OPENINGS. IN SOME CASES IT WILL BE NECESSARY TO WARN THE LOCAL FIRE BRIGADE SO THAT THEY DON'T COME ON A FALSE ALARM!

FIG. 19 FUMIGATION

If you can be given sufficient training you may be able to do small-scale fumigations yourself using, for example, a steel drum and a suitable fumigant that can be applied safely without special equipment. The commodity is placed in the steel drum, the fumigant is applied and the drum quickly covered and sealed down tightly. It must be left for the recommended period of time and then aired outside the store.

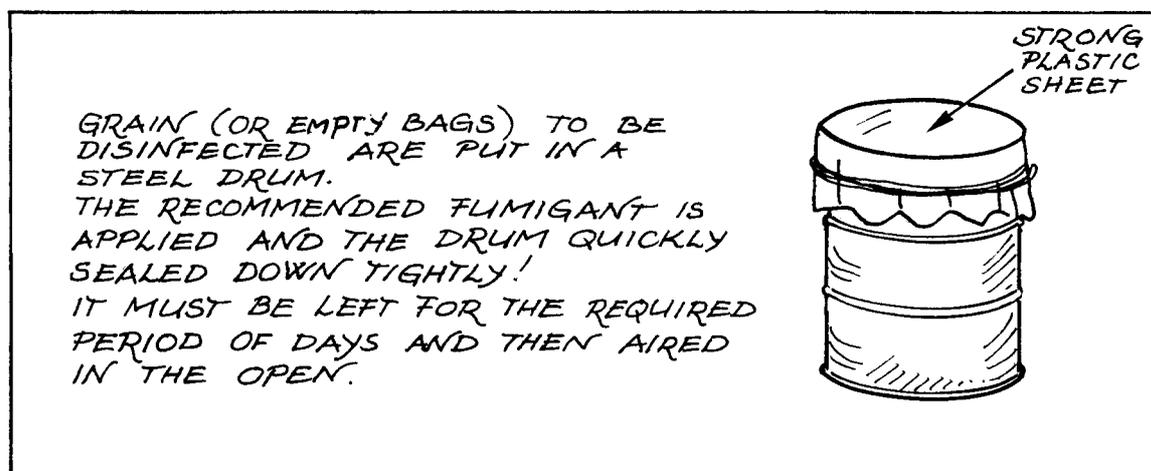


FIG. 20 SMALL SCALE FUMIGATION

Admixing

Cereal grains and some other commodities are effectively protected from infestation by mixing them with a suitable insecticidal powder or spray before storage. Mixing is done



SPREAD THE INSECTICIDE OVER THE HEAP AND THEN MIX THOROUGHLY. A VERY LARGE PILE OF GRAIN CAN BE MIXED BY TURNING IT OVER COMPLETELY WITH SHOVELS 2 OR 3 TIMES.



TURN IT FROM HERE TO THERE ... AND BACK AGAIN

FIG. 21 "SPADE-MIXING" AN INSECTICIDE WITH GRAIN

on a clean floor, or in special mixing drums. This treatment, if correctly applied, will also eliminate moderate infestation already present in the grain.

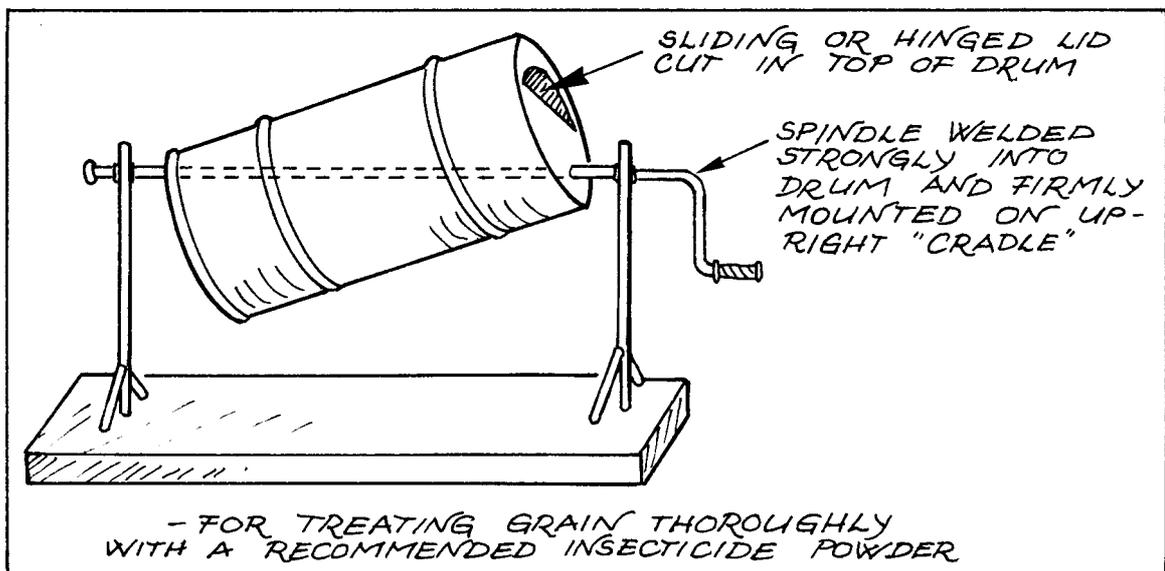


FIG. 22 A SIMPLE MIXING DRUM

Points to remember about pest control treatments

- The most important thing for you to remember is that ALL CHEMICAL TREATMENTS ARE HAZARDOUS.
- Because of the risk involved no one should be allowed to use pesticides or even carry out the procedures mentioned above without special training and authorisation from a responsible person.
- In most countries the authorities responsible for agriculture or food storage have officers knowledgeable about pest control. Some have teams of trained pest-control operators. Their assistance should always be sought for pest-control measures or for special training.
- Many types of insecticides are available which differ in their chemical basis, the manner in which they kill the insects, and the way in which they are applied. We can not, therefore, give specific technical instructions in this booklet on the use of insecticides. You must strictly follow local regulations and the instructions issued by the suppliers.
- Remember, if the wrong type of pesticide is used, or if it is mixed in the wrong quantities, or if it is applied in the wrong way the result may be disastrous. Produce and foodstuff can be spoiled and both animals and people may be poisoned, resulting in illness and even death.

The following "check-list" of general precautions may help insure that you take the greatest care when handling pesticides.

Remember!

- Stocks of pesticides must be very carefully monitored. Only the necessary amounts must be issued. The balance must be put back into locked storage (see page 36) and only released to those qualified to use it.
- Do not use any insecticide unless it is approved and recommended for this purpose in your country.
- Preparation of insecticides - and their application - must be carefully supervised by trained, literate staff. Dilution and dosage rates must be correctly calculated. Take special care when handling the concentrate. Any splashes on skin or clothing must be washed off quickly. Protect your eyes. Use rubber gloves when handling liquid concentrates.
- Always protect yourself from the pesticide. Always wash after handling or using any pesticide. Do not handle food, or smoke a cigarette, until you have done so.
- All containers, sprayers, clothing,, floor areas, etc., which come into contact with any type of pesticide must be scrupulously washed.
- Do not wash out containers down drains or near rivers. Avoid pollution of wells, pools and streams where people or animals may drink, wash or swim.
- Do not use any fumigant unless you have been trained to do so and have all the necessary equipment to do the job safely and effectively.
- Do not admix any insecticide with grains or apply surface sprays or powders to any bagged foodstuff or animal feed without detailed instructions from a responsible person.

- Extra care is needed if you are using chemical treatments on seed. Most seed-dressings are lethal to animals and humans. Drums and other equipment which have been used for seed treatment must not be used for other produce.
- Ensure that all staff involved know all precautions and emergency procedures in case a chemical is inhaled or comes into contact with the body.

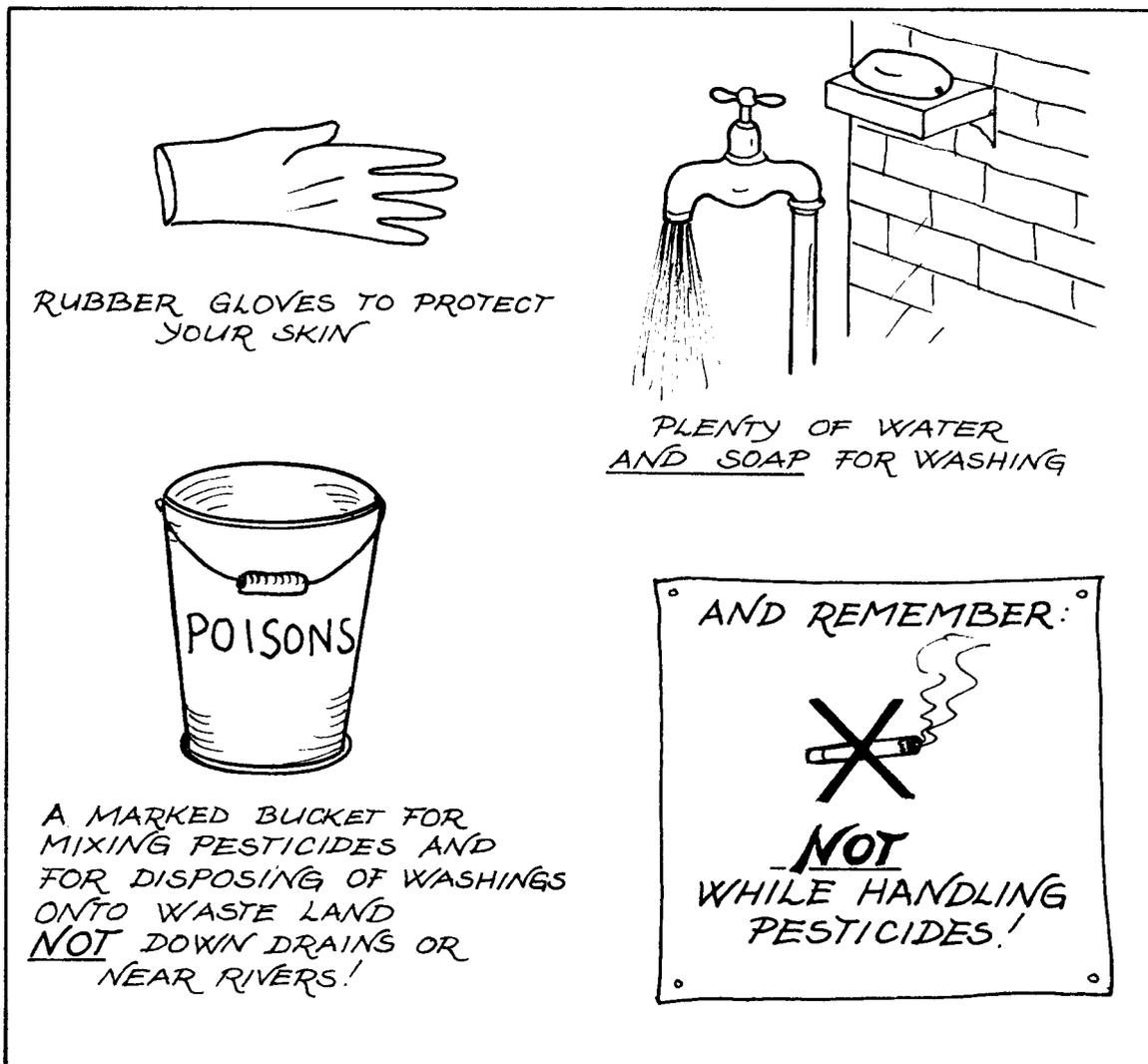


FIG. 23 BASIC PRECAUTIONS IN THE USE OF PESTICIDES

### Bird control

In small stores there should be no need for special methods of bird control. Most methods are dangerous and may be objectionable. Drive the birds out of the store and prevent them from returning.

## OTHER PROBLEMS/

### Spillage

We have already discussed this in detail with regard to pest damage and hygiene. Some spillage is unavoidable, especially with granular commodities in bags, but you must work out a system to reduce it as much as possible. Always be on the look-out for spillage and deal with it when it occurs. Don't let it pile up. Your work system must include:

- Regular daily collecting of minor spillage.
- Immediate collection and rebagging of any major spillage (due, for example, to a burst bag or an upset container). If this is done immediately it is unlikely to be spoiled, otherwise it may be contaminated by pests or pesticides and then you will not know whether or not it is fit for use.
- A recording system. This would be used in weighing and noting down any quantities of spillage either held for cleaning, for separate sale, or which has been destroyed.

BUILD THE STACK CAREFULLY WITH REGULAR "BONDING" OF EACH LAYER

USE A BAG TO COLLECT THE SAMPLES. DO NOT JUST EXAMINE EACH AND THEN THROW IT DOWN!



USE THE SAMPLING SPEAR TO DRAW OUT THE SAMPLE AND TO CLOSE UP THE HOLE IN THE SACKING!

HOLD THE CORNERS OR "EARS" OF THE BAG WHEN CARRYING IT. DO NOT USE "BAG-HOCKS"!



FIG. 24 BUILDING AND SAMPLING A STACK

- Rules for careful handling. (For example, "Don't use bag hooks".)
- Rules for sampling to prevent unnecessary spillage. (For example, "Don't forget to close up the openings made in sacks by sampling spears", "Don't use sampling spears on paper sacks".)
- Regular inspection of the store for spillage caused by pests.
- Regular inspection of drums, tins and bottles for signs of leakage.

### Pilferage

To guard against theft from your store you need a system that enables you:

- to see if a theft has occurred;
- to reduce the risk of theft.

You need to know immediately if the store has been broken into, and whether or not anything is missing. (If the pilferage is not discovered losses may be erroneously blamed on other causes.) After periods when the store has been unattended there should always be a quick inspection made to see that there has been no forced entry. If forced entry is suspected there should be an immediate check on all stock and equipment.

Your security arrangements will depend upon your situation and your knowledge of local risks:

- Do the windows need bars? Can the doors be fastened securely? When the store is left unattended, at least one door must be secured from the outside - an adequate lock is needed. Are the walls and roof strong enough to

stop a thief from breaking in? Do they need reinforcement?

- Do you need to take precautions against minor pilferage such as customers or employees "helping themselves" to goods?

#### Storm damage

Your system to guard against water damage by storm or flood should include:

- the use of stacking platforms for all goods (even metal drums can be damaged by standing water);
- regular, careful inspection of the store for physical defects that could allow damage by rainwater (including wind-blown rain);
- all necessary provisions for repairs before the rainy season begins;
- immediate checks after storms for any damage to the building, especially roof damage.

## STORING CHEMICALS

We have talked about the use of pesticides. Perhaps you have to keep a stock of such chemicals for use in your own warehouse or for sale to members.

We have reviewed the risks involved in handling poisonous pesticides and the precautions you have to take. (pages 37 - 38)

Another chemical product that you probably have to store from time to time is fertiliser. The problems of storage are similar - both pesticides and fertilisers are agricultural chemicals. Special care must be taken with them to avoid accidents and reduce losses.

### Separate buildings

Whenever possible agricultural chemicals should be stored in separate buildings from foodstuff and seeds. If this is not possible you could perhaps divide your store with a partition to keep these products completely separate.

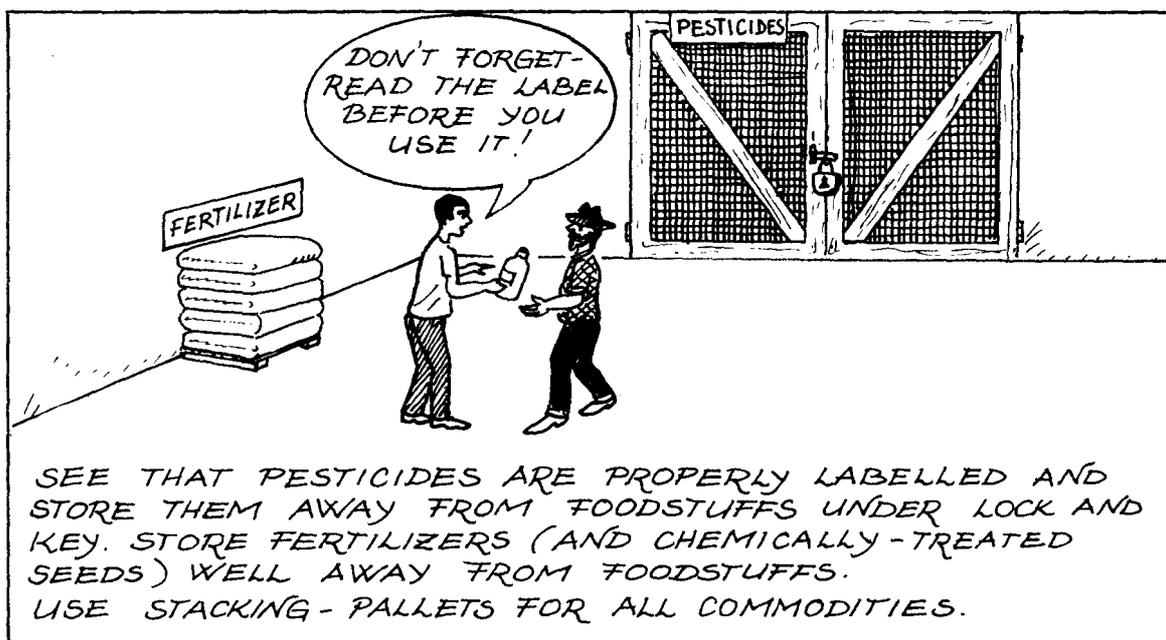


FIG. 25 STORE CHEMICALS SAFELY

Pesticides

Keep all pesticides separately and well away from food-stuff .

- All pesticides are poisonous; even those that are described as "safe to use". Some are highly toxic.

Each lot of pesticide should be clearly identified by a stock record card and labels.

- Check that labels on drums and bottles do not fall off or become unreadable. Never accept - for storage or retail - any pesticides that are not clearly labelled to show:
  - the active ingredient and its concentration;
  - the use for which it is intended;
  - the safety precautions to be taken in preparing and applying the pesticide;
  - the antidotes or medical procedures to use in case of accidental poisoning.

Always store metal drums off the floor to prevent rusting. Use wooden racks.

Always keep and display an up-to-date list of the recommended uses of the pesticide as well as a list of applicable local restrictions for the product you sell.



**GET ALL THE ADVICE YOU CAN! DISPLAY IT!**  
**SEE THAT YOUR MEMBERS KNOW ABOUT IT!**

FIG. 26 RECOMMENDATIONS AND LOCAL RESTRICTIONS

## Fertilisers

Never let fertilisers get wet.

Some fertilisers decompose if they absorb moisture while others solidify.

They must always be stored in rain-proof buildings or, if outdoors, under good tarpaulins - even if they are in plastic bags. Many plastics deteriorate if exposed to strong sunlight for long periods.

Never stack fertilisers directly on a concrete floor.

Moisture may rise through the floor and some fertilisers have a corrosive action on concrete surfaces. They will eat into (and break up) the surface layers of the floor. Stack the bags on wooden dunnage (pallets). If this is not available, lay a heavy-duty plastic sheet on the floor before stacking the bags.

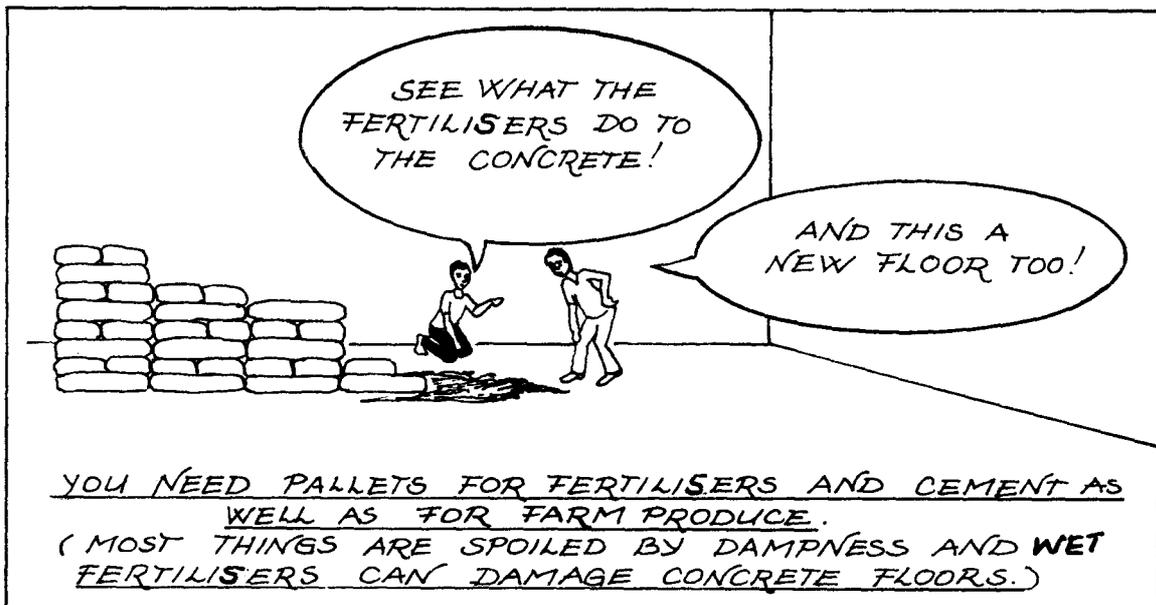


FIG.27 USE PALLETS!

## Stock Rotation

Always practice good stock rotation ("first-in, first-out"). Keep stocks to a minimum to avoid deterioration in storage. Do not hold "carry-over" stocks from year to year if you can possibly avoid it. Pesticides, especially those in ready-to-use packs, may deteriorate quite quickly.

# THE STORAGE BUILDING

We have dealt with several important factors related to safe storage and common causes of storage losses.

This knowledge is essential for anyone involved in the selection of a suitable storage building and its maintenance.

## What kind of store is needed?

There are, of course, many different types of storage buildings depending on the type and volume of crops to be stored.

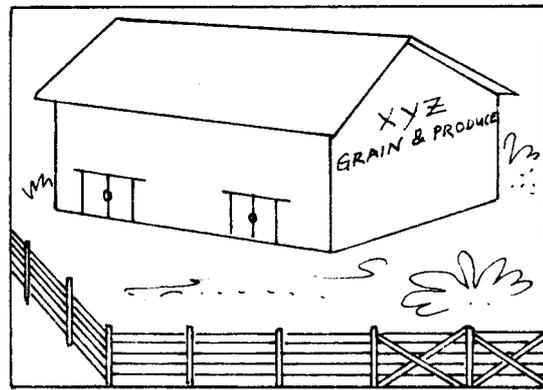
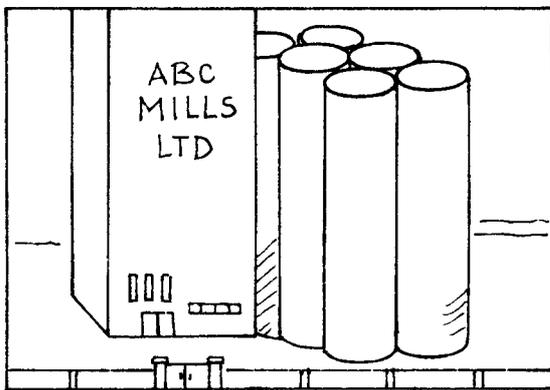


FIG. 28A WHAT KIND OF STORE?

A primary co-operative usually stores relatively small amounts of produce, together with a range of other goods. A multipurpose building is probably the best type of structure for this type of co-operative.

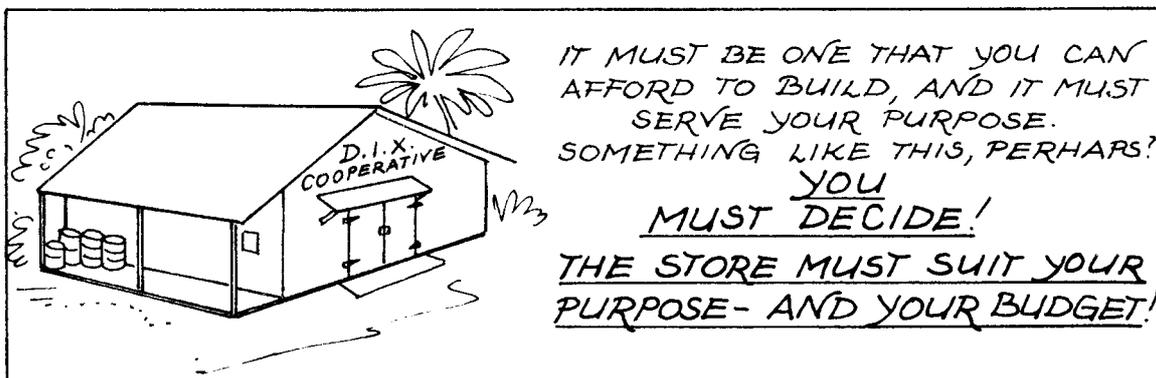


FIG. 28B STORE

Think carefully about your particular needs. What capacity is needed? What special features? What basic requirements? The following paragraphs cover the most important considerations.

### Space requirements

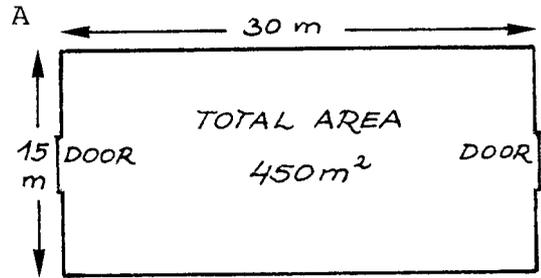
The building should, without overloading, hold the maximum amount of goods that you will need to store.

When you calculate the space needed, you must consider the following. Each ton of produce normally requires between 1.5 and 2 cubic metres of storage space. Remember, however, that you must leave space for inspection and cleaning all round the stacks and that you must not build bag stacks either too close to the roof or too high for stability. Remember also that a store used to hold one commodity will have more capacity (in practice) than the same store used for several different commodities. One large stack, with space around it for inspection, will contain more than several small stacks each with surrounding space for access and inspection.

Do not forget the additional space you may need for intake and dispatch work, grading, weighing and payment for produce to members - if this is to be done in the actual store building. (You can read more about these procedures in the MATCOM Element "Crop Collection".)

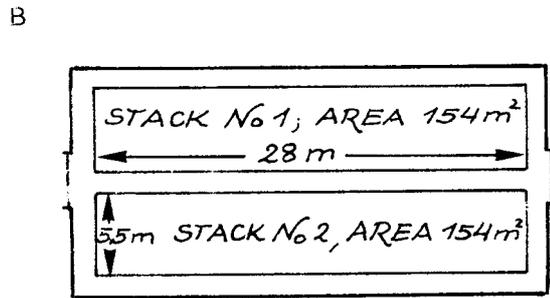
The following sketches show how you calculate the volume available in your store.

This is the total area available. If you can stack up to 6 m height, you have  $30\text{ m} \times 15\text{ m} \times 6\text{ m} = 2,700\text{ m}^3$  available.



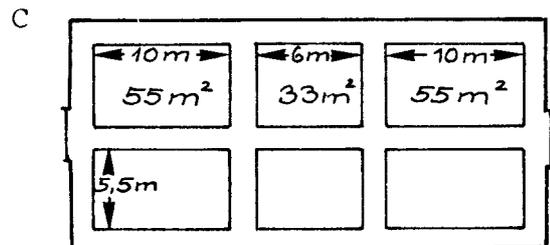
TOTAL VOLUME  
 $450\text{ m}^2 \times \text{HEIGHT TO EAVES}$   
PLUS ROOFSPACE

If you make two large stacks like this, you can store  $28\text{ m} \times 5.5\text{ m} \times 6\text{ m} = 924\text{ m}^3$  in each stack, or  $1,848\text{ m}^3$  in total. That is about 1,232 tons.



STACKING CAPACITY  
 $2 \times 154\text{ m}^2 = 308\text{ m}^2$   
 $\times$  STACK HEIGHT

Calculate the volume of the produce in these six stacks.



STACKING CAPACITY  
 $4 \times 55\text{ m}^2 + 2 \times 33\text{ m}^2$   
 $= 286\text{ m}^2 \times \text{STACKING HEIGHT}$

(Right answer  $1,716\text{ m}^3$ . How many tons is this?)

FIG. 29A, 29B, 29C  
STORAGE CAPACITY FOR BAG STACKS DEPENDS UPON THE NUMBER OF STACKS AND STACK HEIGHT.

Check for yourself, also, the volume per ton for the various commodities that you have to store.

Safety requirements

The building must be well sited.

The site should be chosen to avoid the risk of flooding and to reduce rodent problems. (See p. 22.) (It should also be conveniently located for members, with adequate road access).

It must be rain-proof.

Metal roof sheets must be properly overlapped to prevent the entry of heavy rain. They should be nailed down with proper roofing nails as shown (see figures below). If bolts are used, they should be sealed with washers or jointing compound. The roof should overhang the side walls sufficiently to protect them from rain and prevent wind-blown rain from entering at the eaves. Loading plinths should be sheltered and sloped to prevent rain-water running in under the door.

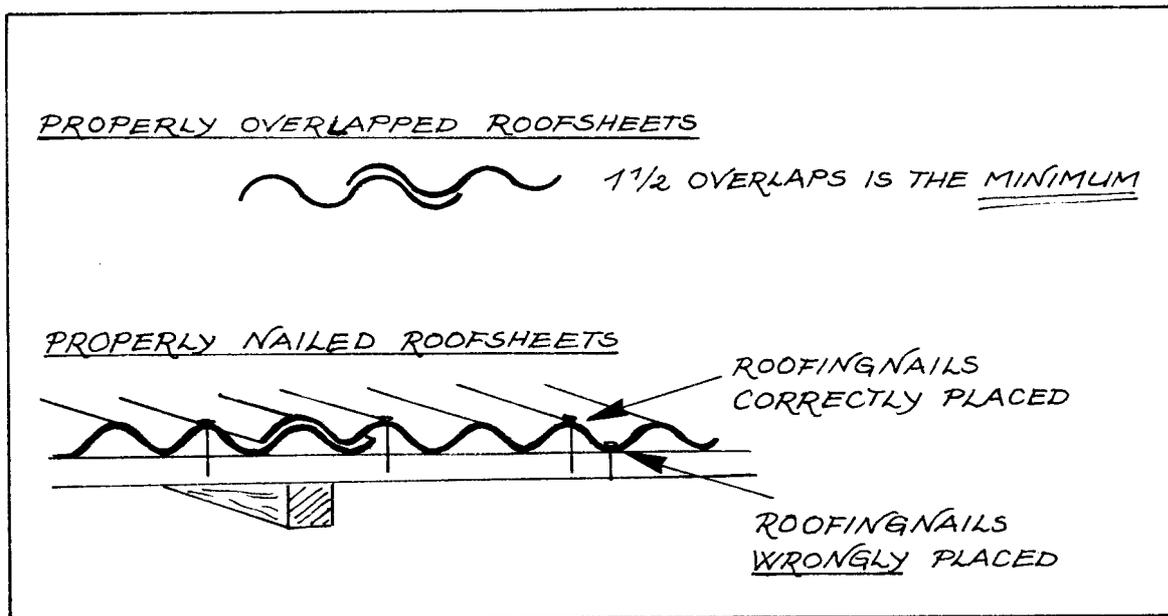


FIG. 30 ROOFING SHEETS MUST BE CORRECTLY FITTED TO KEEP OUT RAIN

You may also need a separate small store for agricultural chemicals.

The store should also offer protection for commodities against rising damp.

The walls should have a proper damp-proof course to prevent moisture from rising in them. The floor should be at least 30 cm above ground level. Concrete floors should, if possible, incorporate a complete moisture barrier (such as 750 gauge polyethylene).

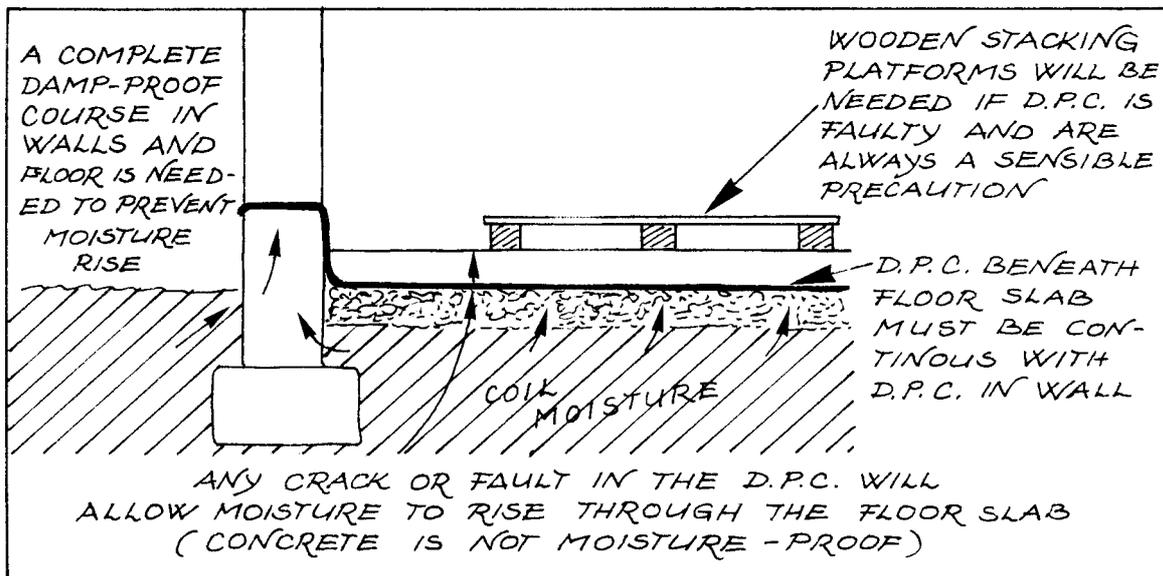


FIG. 31 DAMP FLOORS ARE A HAZARD IN MOST STORES

The store should be pest-proof.

Walls, floors, doors and all openings or ducts for pipes or cables should be made rodent-proof. If necessary, eaves, windows and ventilators should be made rodent-proof and bird-proof. (See pages 22 - 24.)

It should be secure against thieves.

A strong door with a good lock is essential. Windows should be burglar-proof and walls strongly built, preferably of concrete, brick or stone. In this connection you should note that corrugated galvanized steel sheet (26 gauge) on a well-built frame, while strong and secure, is more difficult to keep clean.

The store should be well ventilated.

A cool storage environment with good air-flow will reduce the rate of deterioration of stored products. If possible, ventilators should be fitted with shutters that can be closed easily to keep out hot, humid air. Shutters are also needed for the effective use of some pest control treatments.

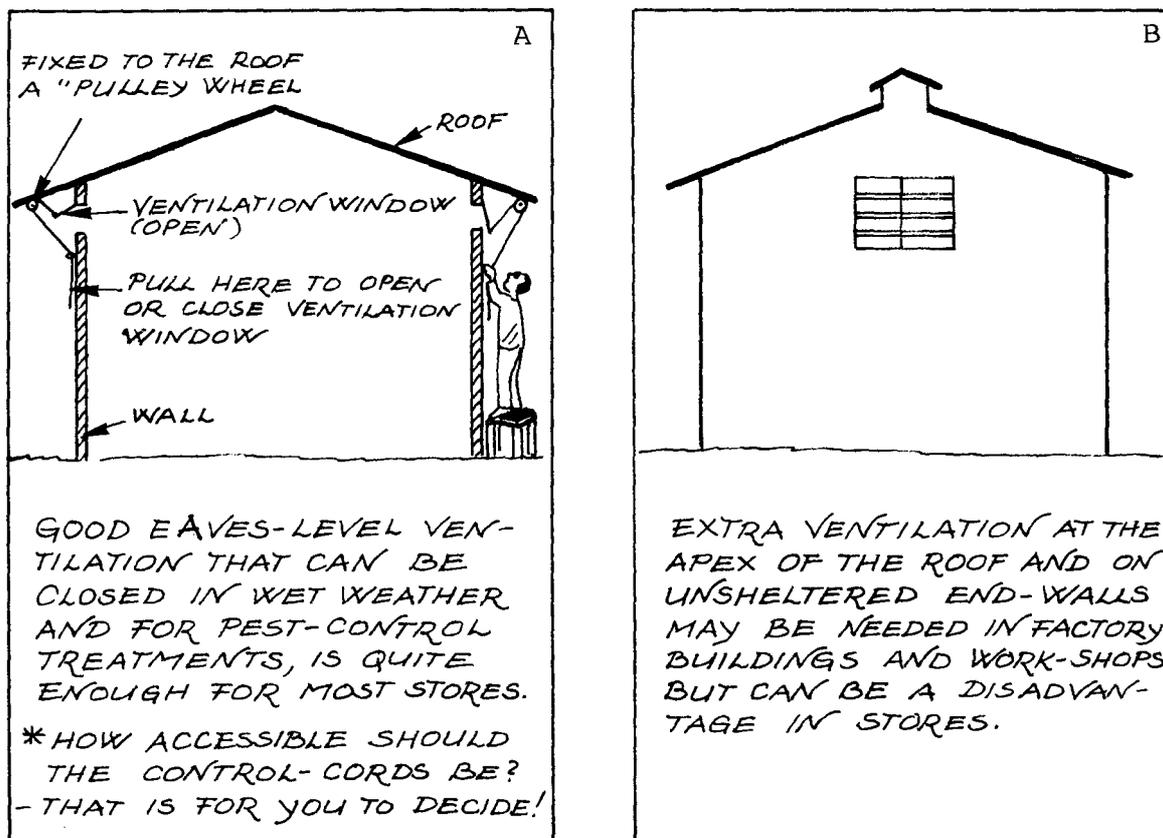


FIG. 32A AND 32B VENTILATION IS IMPORTANT

If separate ventilation is undesirable, or too expensive to fit and pest-proof properly, then the store must have large doors, at opposite sides (or ends) of the building, that can be opened when necessary to allow adequate ventilation.

It should be easy to clean.

Frequent and thorough cleaning is needed for pest control. If the store is designed with that in mind, it can be cleaned more often and with less trouble.

Summing up - the most important features of a good store building:

- it must suit your purpose and your budget;
- it must be large enough to prevent over-loading;
- it must be well-sited, for access and for safety from flooding;
- it must be weather proof;
- it must be protected against rising damp;
- it should be protected against rodent, bird and other pests;
- it must be secure against thieves;
- it should have adequate, controllable ventilation or it must have large doors on both sides;
- it must be easy to clean.

## GOOD STORAGE PRACTICE

It is your job to manage the storage arrangements for your co-operative to protect the produce as well as you can. Can you prevent or reduce losses so that storage is worthwhile? Is it enough to have a good building and familiarity with the various problems involved? Can you meet the standards set by your buyers?

It depends on what you do, not on what you have or what you know. To organise and supervise everything we have discussed (the many inspections, control measures and safety practices), you certainly must be an effective manager and you must be firm about your own buying standards.

Some of your other duties as manager are closely related to the task of storage management (for instance, organising the intake of produce or the reception of farm supplies). These are discussed in the MATCOM booklets "Crop Collection" and "Supply Services". The one on "Planning" is useful in this connection.

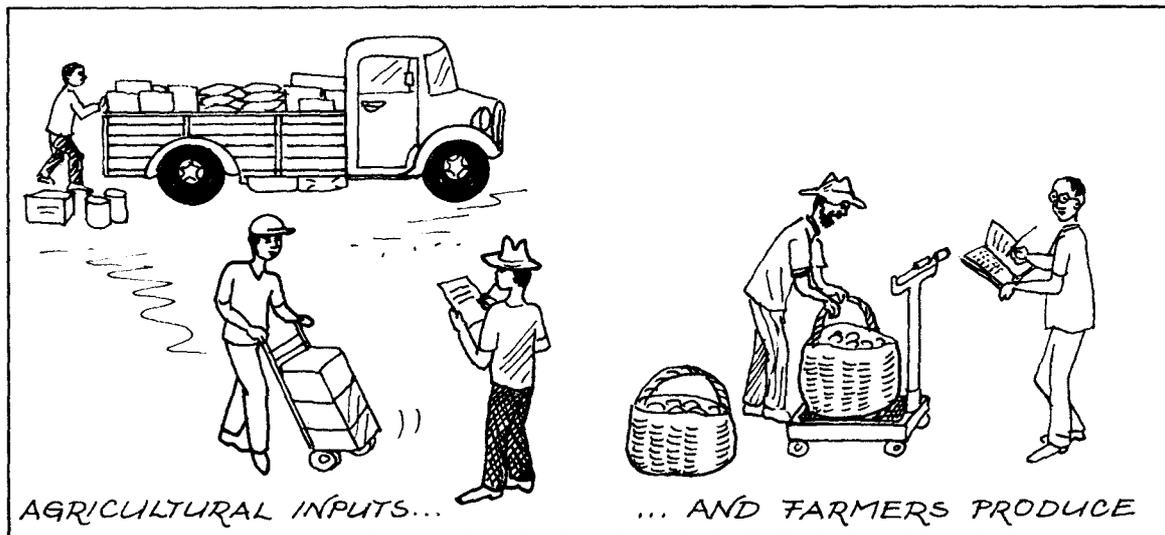


FIG. 33 CHECK ALL GOODS RECEIVED AND DISPATCHED

Let us now look at some further considerations in the practice of good storage management... and at some specific tasks.

### Care of bags and other containers

Wash and re-use jute bags.

- Jute bags cost money and the cost will obviously be reduced if the bags can be reused. Organise a system for effective utilisation of them.

Do not keep untidy piles of damaged or used sacks in your store. They will soon become a home for rats, mice and insects. Useful bags should be cleaned and repaired, laid flat in bundles of twenty or twenty-five, rolled together and tied with string. They can then be stacked neatly on storage pallets and given a stock card. Useless sacks should be taken out and burned.

Return empty containers to suppliers without delay.

- Drums, cans, bottles, and other containers to be returned to suppliers should be cleaned out and kept in a separate area to await collection. Do not let the store become loaded with empty containers.

### Stacking

Always leave sufficient space around the stacks for the free movement of goods, routine inspection, stock-taking and cleaning. Never stack goods directly against walls, roof supports, or doors.

Establish a standard stacking layout in your store. Painting lines on the floor to mark stack outlines may help. It will certainly be useful to mark the gangways needed between stacks and walls.

Always keep commodities of different types stacked separately or with a clear marker between them.

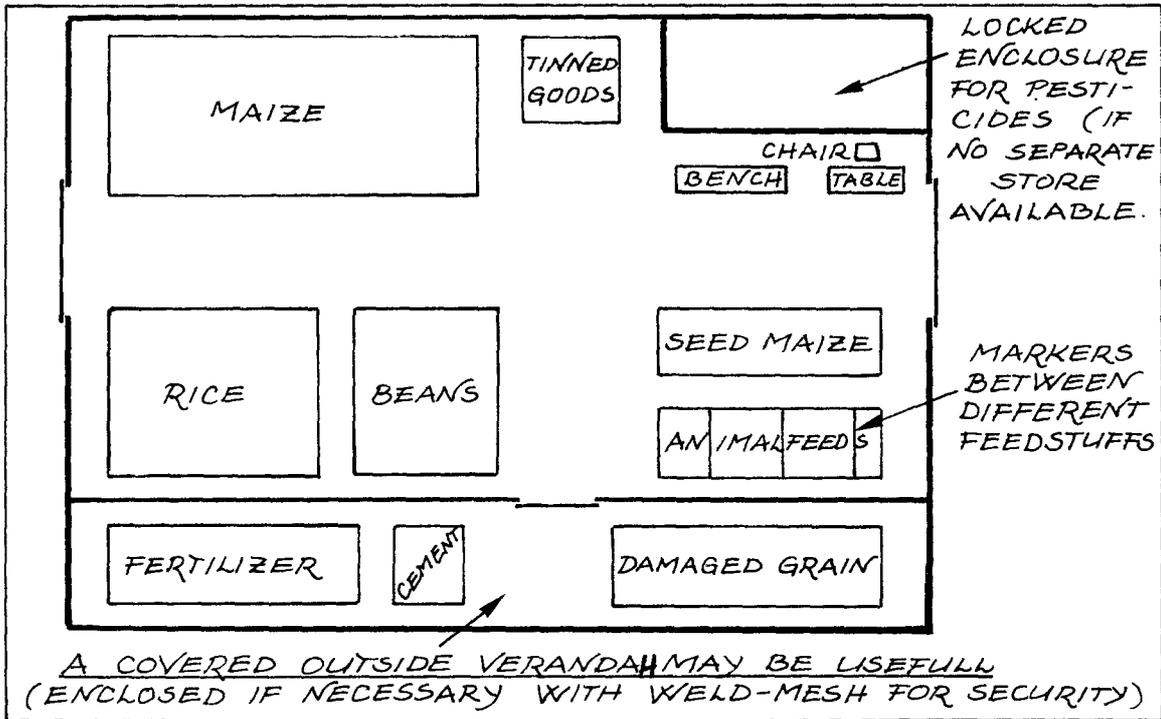


FIG. 34 SEGREGATE STOCKS AT INTAKE FOR INSPECTION, STOCK-TAKING, CLEANING AND DISPATCH

Build up layers of bags in a stack so that the sides will not collapse. This is called "bonded stacking". Insure that the sides of the stack are vertical or slope slightly inward, not outward! If the same stacking pattern is always used it will also assist in counting bags for stock-taking.

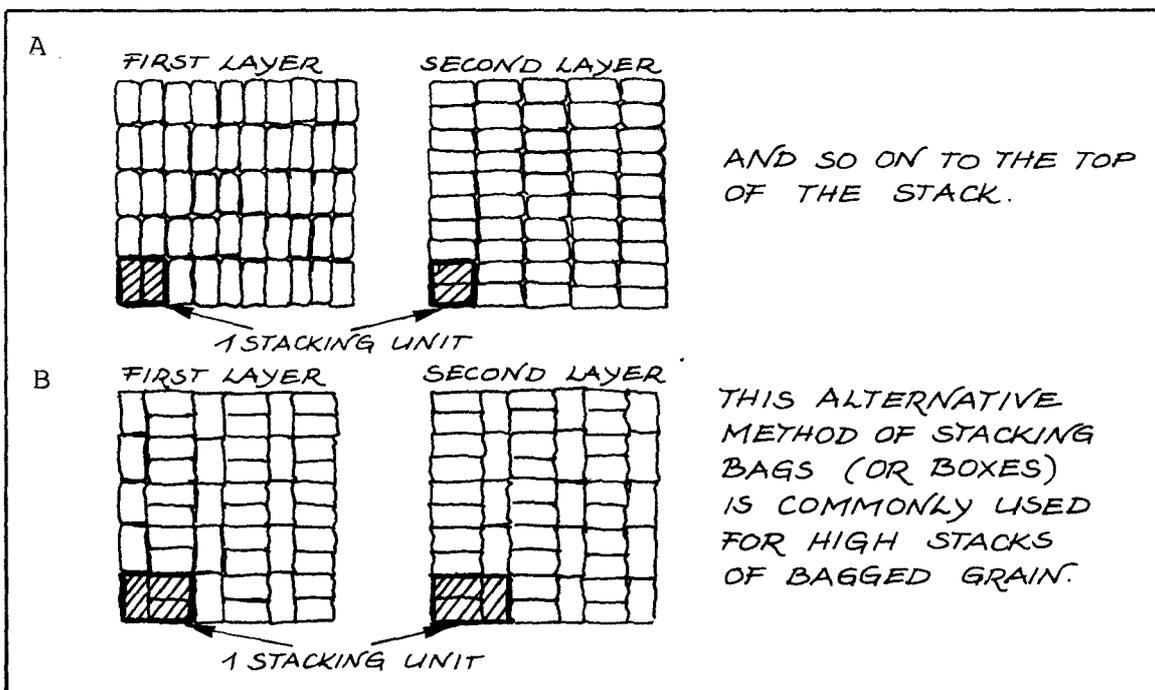


FIG. 35A AND 35B HOW TO STACK BAGS OR BOXES WITH CROSS-BONDING

Some bagged commodities lie best in a "unit" of five bags. Try to work out the best arrangement for compact, stable stacking with your own **goods**.

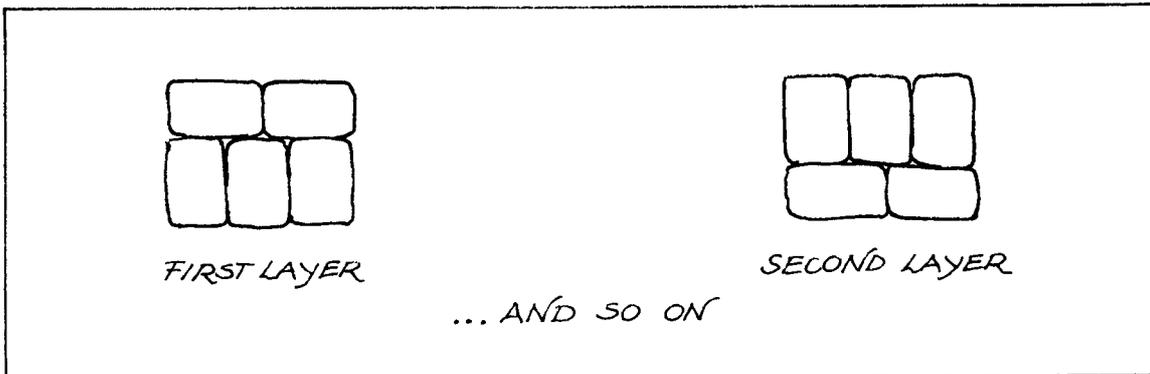


FIG. 36 SOME SACKS LIE BETTER IN A GROUP  
OR UNIT OF 5 BAGS

Bagged grain can be stacked high without damage. If the store has a high enough roof - so that space can still be left above the stack - you can stack most grain at least 20 - 25 bags high if the stacking is properly done. With cardboard cartons and wooden boxes you must be more cautious. How strong are they?

#### Routine cleaning and maintenance

Programme inspection, cleaning and maintenance work.

Make out a programme for yourself and your staff which provides for the implimentation of important tasks.

- Frequent inspection and cleaning: work out instructions and check-lists on how the work should be done, when, and by whom. Keep a diary in the store to remind you of inspections and produce treatments.
- Regular maintenance: lubrication of locks, bolts, hinges and other metal mechanisms; repainting of wood and metal work.
- Repairs: to be done as needed.

Stock records

An important aspect of effective storage is proper record keeping of the crops and farm supplies that are received, stored and issued by the co-operative.

A "Stock Record Book" is generally kept in the office. Bin cards are generally used for records in the store.

The following guidelines concern the recording work done in the store:

- Give each commodity - or stack of produce - a bin card; pin it to the stack or on the wall nearby.
- Each variety, grade or packing type should have its own place and its own bin card.

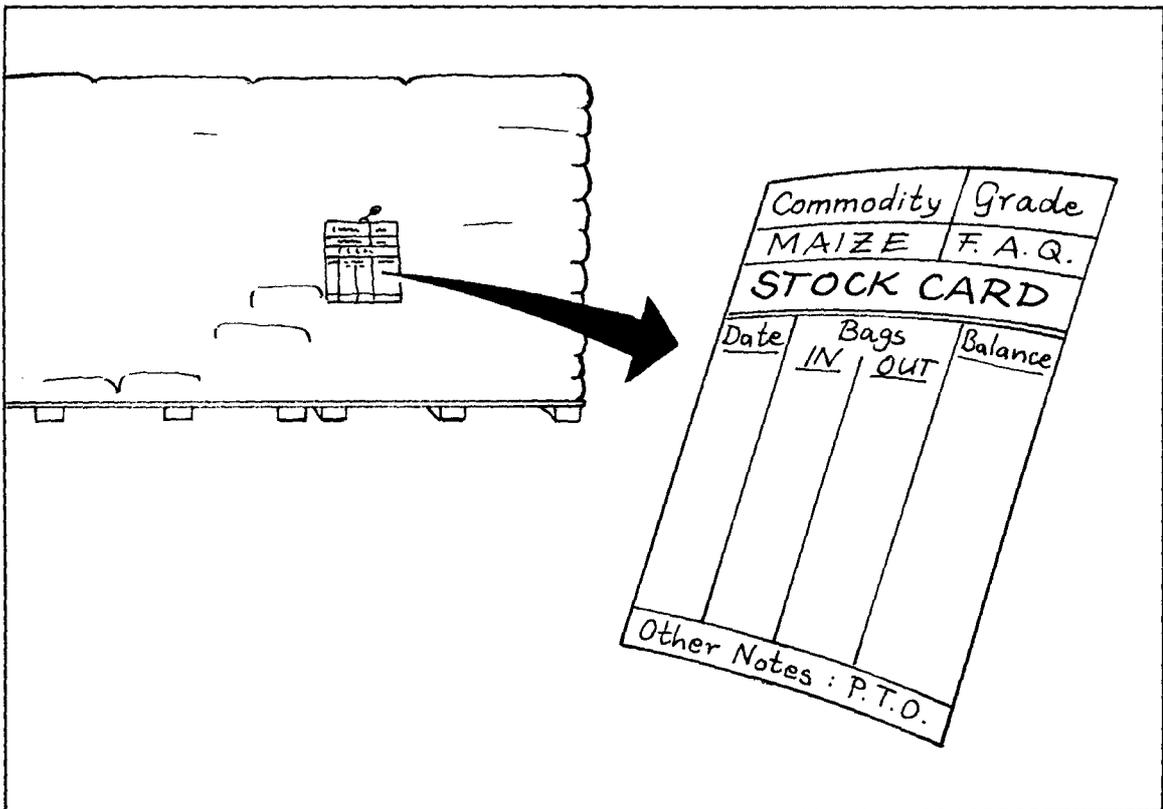


FIG. 37 KEEP AN UP-TO-DATE STOCK CARD ON EVERY STACK

- Note any movement of produce (changes in the stock) on the card.

Note the dates and quantities of intake and dispatch, and the balance in stock. The entries should give reference to and tally with receipt or dispatch notes which are passed on to the office for corresponding entry in their books.

- Note any observations made on moisture content or pest infestation during the regular inspections.
- Note all details of treatments given to the produce.
- Note details about substandard stock and any goods declared unfit and destroyed.

All entries on the cards should be signed by whoever is responsible for the action taken.

Remember that you may be required to provide information about all these things for the goods that you have in store and for the goods that you have dispatched.

Remember, too, that if ever you need help or advice on storage or pest control the expert you call on will be better able to help if you can provide these details.

Finally, do not forget that it will be up to you, on the basis of your own experience with storage, to let your members know the standards for quality at intake that you must set if your operations are to be profitable to all concerned.

## STORAGE COSTS

We said in the introduction to this booklet that many co-operative societies store the members' crops for some time because of the benefits to the members (usually in the form of better payment for the produce).

In this booklet you have studied the problems involved in storage. You can now appreciate the fact that to manage storage properly you will incur many costs.

obviously, you would not want to store a crop for six months if you can receive the same payment for it today as after storage. That would mean incurring unnecessary costs - but if the benefits exceed the costs, such storage would be worthwhile.

All your storage decisions must be based on a comparison of costs and benefits. Do not simply accept the argument that it is "normal practice" to store all crops for some time. Storage is not a matter of course, it is an economic decision. The management of a co-operative has to ascertain the costs of storage and compare them with the benefits. Not until you have completed such calculations will you be able to compare your options and make your decision: storage in the co-operative, storage on members' farms, or perhaps no storage at all but immediate dispatch to the produce buyer.

To help you estimate your storage costs, we offer some basic guidelines here.

Begin by making a list of all possible storage costs. You will discover that it is difficult to estimate costs in all circumstances. Nevertheless, you must try to put a figure to each type of cost.

Types of storage costs

- Storage buildings.

You can easily assess this cost if you pay rent for a building. If you own it, you have a yearly "depreciation cost". (For instance, if you paid T\$100,000\* to build a store and plan to use it for 20 years, your annual cost in terms of the building depreciation will be T\$5,000.)

- Equipment.

You should include the specific equipment needed for moving produce into and out of storage. For expensive equipment, apply the same calculation methods as for a building: i.e. allow for "depreciation costs".

- Packaging.

Include only the packaging required for storage.

- Labour.

Include the wages of people directly employed in storage plus a proportion of the supervision and management salaries.

- Crop loss.

If you can estimate the percentage of actual crop loss (due to shrinkage, mould, pests, etc.) during storage, you can also estimate the loss in monetary terms.

- Decline in produce value.

Mould damage or pest infestation may cause downgrading of the produce and lower prices.

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\* We use an imaginary currency here, because this booklet is used in many countries. We call it "Training dollars" (T\$).

- Insurance.

You may need insurance to cover certain risks associated with storage such as theft, fire, and flooding).

- Money tied up in storage.

If you sell a crop immediately you receive money which can earn bank interest. If you store the crop you miss this opportunity; hence it is a "cost".

- Other costs.

You will need money for cleaning equipment and materials, for maintenance, for pesticides, etc. Do not overlook the labour costs for maintenance and pest control.

Estimating costs and benefits

Below is a simplified example which can be used as a model when estimating and comparing costs and benefits of storage.

The manager of a co-operative was offered T\$200 a ton for maize just received from his members. He knew that if he stored it for six months, it would bring T\$230 a ton. He had to recommend to the management committee whether to sell the maize immediately or to put it into storage for six months.

He had the following information:

- The total amount of maize available was 1,000 tons.
- The labour cost for the period of storage would be T\$1,500.
- Rental fees of building and equipment for storage would amount to T\$600.

- The insurance would cost T\$2,000 for the storage period.
- The banks pay an interest of 10% on deposits.
- Predictable storage losses, with available control measures, would total 50 tons.

Here are the manager's calculations:

Benefits of storage

Revenue from sale in six months  
is 950 tons x T\$230 T\$218,500

(This allows for the predicted  
storage loss of 50 tons.)

Revenue from immediate sale  
is 1,000 tons x T\$200 T\$200,000

Benefits from storage = T\$ 18,500

Costs of storage

|   |           |
|---|-----------|
| Labour                                      | T\$ 1,500 |
| Rent  | 1,000     |
| Insurance                                   | 2,000     |
| Cost of money (10% x T\$200,000 x 1/2 year) | 10,000    |

Total costs of storage = T\$ 14,500

Obviously, the society should be T\$4,000 better off if it stored the produce for six months rather than selling it at once.

The manager expected, based on experience, that he would not lose more than 5% of the crop during the storage (50 tons out of 1,000 tons makes 5%). But what if something happened

to increase the losses to 7 1/2%? He would then have only 925 tons to sell and the revenue would be only T\$212,750. The benefit would be reduced to T\$12,750, which is less than the cost! Immediate sale would be more economical. (We can see how important it is to reduce storage losses as much as possible. It is also important to know what reductions can be achieved in practice by the "costed" methods.)

Mathematical calculations of this type will help a manager to judge whether storage will be profitable or not. Experienced managers know that while it is not possible to rely on the predicted figures alone, they need them to make a first quantitative cost/benefit analysis. The managers then look at all factors from all points of view and make their final decisions. In subsequent operations they will reassess their costs and benefits, including the cost-effectiveness of their pest control measures, and will modify these, where necessary, so as to maximise the benefit/cost ratio.

# "CHECK-OUT"

To prove to yourself that you have fully understood this Element you should now do a practical exercise.

Take a look around your store. Use the list below as a check-list and mark whether each statement is True (T) or False (F).

If the results show too many "F" responses, you might want to improve your storage management. Good luck!



## The building

TRUE/  
FALSE

- \_\_\_\_\_ 1. The type and size of your storage building is just right for your needs.
- \_\_\_\_\_ 2. The roof is absolutely rain-proof.
- \_\_\_\_\_ 3. The roof overhangs the side ;calls so that no rain enters at the eaves.
- \_\_\_\_\_ 4. Ground water, after a storm, cannot enter the store.
- \_\_\_\_\_ 5. The floor and the walls have a damp-proof course to prevent damp from rising.
- \_\_\_\_\_ 6. There are metal plates fitted at the bottom of wooden doors and frames to prevent gnawing rodents from entering.
- \_\_\_\_\_ 7. There are wire mesh screens fitted to all ventilators, windows and other openings.
- \_\_\_\_\_ 8. The building is burglar-proof.
- \_\_\_\_\_ 9. The building can be well-ventilated and all doors, windows or other ventilators can be easily opened and closed.
- \_\_\_\_\_ 10. The floor is easy to clean.

Storage practices

- \_\_\_\_\_ 11. The stacks of bags are no higher than is known to be safe and convenient.
- \_\_\_\_\_ 12. The stacks are built uniformly and are stable.
- \_\_\_\_\_ 13. There is enough space all around the stacks to allow for inspection and cleaning.
- \_\_\_\_\_ 14. Different commodities are kept in different parts of the store.
- \_\_\_\_\_ 15. There is easy access to all commodities in the store.
- \_\_\_\_\_ 16. There is a bin card for each commodity in the store.
- \_\_\_\_\_ 17. All movement of goods and treatments to the produce are noted on the bin cards immediately.
- \_\_\_\_\_ 18. The staff has been trained to avoid spillage.
- \_\_\_\_\_ 19. Sampling spears are used cautiously to avoid damage to bags.
- \_\_\_\_\_ 20. Hooks are not used on the bags.
- \_\_\_\_\_ 21. The rule "first in - first out" is sensibly applied.
- \_\_\_\_\_ 22. You have a "fixed schedule" for inspection and cleaning; the staff know when to do it, how to do it and who will do it.
- \_\_\_\_\_ 23. All empty bags are washed and neatly stacked for re-use.
- \_\_\_\_\_ 24. All empty containers are returned to the supplier without delay.

Moisture and shrinkage

- \_\_\_\_\_ 25. You know the moisture content of the produce at intake and at dispatch.
- \_\_\_\_\_ 26. You do not accept produce which is too wet for storage.
- \_\_\_\_\_ 27. You consider the moisture content when you pay members for the produce.
- \_\_\_\_\_ 28. Your members understand and agree with your methods for measuring moisture and calculating shrinkage.

- \_\_\_\_\_ 29. You never place any bags directly on a floor which is completely damp-proof, but use dunnage and/or wooden platforms.
- \_\_\_\_\_ 30. You arrange adequate ventilation of the produce in the store whenever it is needed, provided that the weather is favourable.
- \_\_\_\_\_ 31. You take action immediately upon discovering produce damaged by moisture.

### Pests

- \_\_\_\_\_ 32. You keep the store scrupulously clean to make life difficult for pests.
- \_\_\_\_\_ 33. You keep the outside area clean and free from rubbish which can harbour pests.
- \_\_\_\_\_ 34. You inspect regularly and frequently for signs of rodents and insects in the store.
- \_\_\_\_\_ 35. You know and can apply suitable, effective methods for control.
- 36. You know and can apply suitable, effective methods for insect control.
- 37. You have the equipment and materials needed for pest control.
- 38. You know the risks and the safety regulations for use of pesticides and you can take the responsibility for any use of hazardous chemicals in your co-operative.
- 39. You keep all stocks of pesticides under lock in a separate place.

### Costs

- 40. You know the total cost of bags and other containers used for storage.
- 41. You know the value of the losses in storage due to shrinkage and pest infestations.
- 42. You know the total cost of your storage operations.
- 43. You know that the benefits exceed the cost of storage.
- 44. You consider continuously ways to reduce storage costs and to increase storage benefits.

## COMPLEMENTARY EXERCISES

To complete your studies of this topic, you should take part in some of the following exercises.



### The storage building

Make up a check-list, in brief note form but complete, for all the points you would look for if you were inspecting a store that your co-operative might want to rent.

### The shrinkage problem

Discuss and analyse the shrinkage problem in your co-operative. Suggest improvements to

- a/ the measuring of weight losses due to shrinkage;
- b/ accounting for the losses;
- c/ informing the members about the problem.

### The pest problem

"Serious infestation problems can be avoided by keeping rats and birds out of your store and by ensuring that produce and other goods delivered to the store are free of infestation."

Comment on this statement. How far is it true? What else can be done, if you have no means of disinfecting large stacks of produce, to prevent the development of serious insect infestation?

### The paperwork

Plan the lay-out of a standard stock card and stock record book for use in your store. Draft them with all the headings needed to remind the user of everything that should be recorded, but keep them as simple as possible to make the paperwork easy.

Have you studied these other MATCOM "Learning Elements" for staff of agricultural co-operatives?

ISBN

- Basic economics of an agricultural co-operative 92-2-103699-5
- The budget 92-2-103698-7
- Supply services 92-2-105021-1
- Crop collection 92-2-105161-7
- Planning 92-2-105215-X
- Transport 92-2-105820-4

MATCOM has also designed a comprehensive six-day course on "Storage Management" as well as several other courses for managers of agricultural co-operatives.

The Trainer's Manuals for the following courses are available from ILO:

ISBN

- Collecting and receiving agricultural produce 92-2-103164-0
- Transport management 92-2-103855-6
- Storage management 92-2-103165-9
- Marketing of agricultural produce 92-2-102983-2
- Supply management 92-2-102365-6
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- Staff management 92-2-102939-5
- Work planning 92-2-103479-8
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