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The control of vertebrate pests is important to prevent economic losses and to safeguard human health. The usual control practices involve the protection of food either at preharvest or at postharvest stages by chemical and nonchemical or mechanical means. Sometimes good control can be achieved by employing one method only, but effective and lasting results are more usually dependent on the application of different methods either in combination or in sequence, that is by integrated pest management.

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# INTEGRATED PEST MANAGEMENT

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PAKISTAN AGRICULTURAL RESEARCH COUNCIL  
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# CONTROL OF VERTEBRATE PESTS IN PAKISTAN

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## INTRODUCTION

The control of vertebrate pests is important to prevent economic losses and to safeguard human health. The usual control practices involve the protection of food either at pre-harvest or at post-harvest stages by chemical and non-chemical or mechanical means. Sometimes good control can be achieved by employing one method only, but effective and lasting results are more usually dependent on the application of different methods either in combination or in sequence, that is by integrated pest management.

## CHEMICALS IN VERTEBRATE PEST MANAGEMENT

Chemicals used in vertebrate pest management are classed in several categories, such as rodenticides, fumigants, repellents, avicides, chemosterilants, etc. They are used against several kinds of vertebrates such as rodents, birds and other pests like, wild boar.

Rodenticides, which are commonly organic or inorganic compounds are classified arbitrarily (based on action) into four groups:

1. Acute or single dose
2. Chronic or multiple dose e.g. anticoagulants
3. Fumigants
4. Chemosterilants

### 1. ACUTE RODENTICIDES (TABLE I)

An acute rodenticide can be lethal following the consumption of one feed of bait. Most of the acute poisons currently marketed for the control of rodents have proven to be fairly effective but, at the same time they are highly toxic to non-target animals such as birds and wildlife of national importance. Therefore, there can be high risks of accidental poisoning. Their use is less expensive, however, the continuous use can

Table 1: Acute (Single Dose) Rodenticides and the Percent of Active Ingredients Commonly Used in Baits for Rodent Control

Common Name	Chemical Name & Formula	Percentage Active Ingredients Recommended in Baits
Zinc or Zinc Phosphide	Zinc Phosphide, $Zn_3P_2$	1.0 - 2.0
Red Squill	Scilliroside Glycoside $C_{32}H_{46}O_{12}$	10.0
1080	Sodium Fluoroacetate or Sodium Monofluoroacetate, $FCH_2$	0.22 0.03 for wild bear control
1081	Flouracetamide	1.0 - 2.0
Thallium sulphate	Thallium Sulphate	Restricted
Strychnine	Strychnine Alkaloid or Strychnine Sulphate	Not recommended for rat control
Arsenic	Arsenic Trioxide	Rarely used
Norbormide	5 (a hydroxy-a-2-pyridylbensylidene)-5-norbornene-2-3-dicarboxide	0.5 - 1.0
Antu	Alpha Naphthylthiourea	0.75 - 3.0
Vacor (DLP787)	1-(3-pyridylmethyl)-3-(4-nitrophenyl) urea	1.0 - 2.0
Phosphorus	Phosphorus	1 to 3%. Seldom used
Barium Carbonate	Barium carbonate	Rarely used
Bromethalin	$C_{14}H_7Br_3F_3N_3O_4$	0.1% or 100 ppm

cause bait shyness and this adds cost to the control operations. There is no perfect antidote for these poisons in case of accidents.

## 2. ANTICOAGULANT RODENTICIDES

The various anticoagulant rodenticides have a similar physiological reaction in that they disrupt the mechanism that controls blood-clotting and cause fatal internal haemorrhages to develop. Their action is cumulative and most, except for certain of the second-generation materials, need to be ingested, over a period of several days to be effective. Anticoagulants possess two main advantages over acute rodenticides: i) they rarely, if ever, cause bait shyness, and ii) primary and secondary poisoning hazards to non-target species are reduced and an effective antidote, vitamin K<sub>1</sub>, is available.

The older anticoagulants, introduced prior to 1975, have come to be called the "first generation" anticoagulants because of their lower toxicity to rodents and need for cumulative or multiple dosing. After 1975, a new class of much more toxic anticoagulants were introduced, and these have become known as "second generation" anticoagulants. Among these, some require only one dose to kill all test rodents. The time to death is still about the same duration, 4 to 10 days, whether using "first generation" or "second generation" materials. The fact that one dose will kill all or nearly all of certain species of rodents after they eat the bait, has led to the use of these anticoagulants in much the same manner as acute toxicants. The idea of "pulsed" baiting, where baits are laid for one night but on a once-per-week basis, has been advocated. This technique has generally been rather successful and requires lesser amounts of anticoagulant baits than would be used with the multiple dose materials. The percent of active ingredients in use in each of the common anticoagulant rodenticides are listed in Table 2.

Advantages and disadvantages of acute and chronic poisons are given in Table 3.

## 3. FUMIGANTS

Fumigants are used to kill rodents and their ecto-parasites living in inaccessible areas in buildings, ships or in burrows in the soil. Most fumigants are quite dangerous, both to the persons using them and to other humans or animals in the immediate area. Fumigants having a molecular weight less than 29 tend to rise slowly to the top of the burrow systems when used in soil. Factors important in burrow fumigation are the

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Table 2: Anticoagulant Rodenticides and Their Usual Concentrations in Finished Bait

Common Name	Chemical Name	Concentration (%w/w)
<u>First Generation Anticoagulants</u>		
Warfarin	3-( $\alpha$ -Acetonyl Benzyl)-4-hydroxycoumarin	0.025%
Fumarin	3-( $\alpha$ -acetonylfurfuryl)-4-hydroxycoumarin	0.025%
Racumin (Coumatetrayl)	3-( $\alpha$ -tetralyl-4-hydroxycoumarin)	0.0375%
Pival (Findone)	2-Pivalyl-1,3-indandione	0.025%
Diphacinone	2-diphenylacetyl-1,3-indandione	0.005%
Rozol (Chlorophacinone)	2(2-p-chlorophenyl- $\alpha$ -phenylacetyl)-1,3-indandione	0.005%
<u>Second Generation Anticoagulants</u>		
Difenacoum (Ratik)	3-(3-p-diphenyl-1,2,3,4-tetrahydronaph-1-yl)-4-hydroxycoumarin	0.005%
Bromadiolone	3-[3-(4'-bromo[1,1'biphenyl]-4-yl)-3-hydroxy-1-phenylpropyl]-4-hydroxy-2H-1-benzopyran-2-1	0.005%
Brodifacoum	3-(3-[4'-bromobiphenyl-4-yl]-1,2,3,4-tetrahydronaphth-1-yl)-4-hydroxycoumarin	0.005%
Flocoumafen	3-[3-(4'-trifluoromethylbenzyl-oxyphenyl-4-yl)-1,2,3,4-tetrahydro-1-naphthyl-4-hydroxycoumarin	0.005%

Table 3: Advantages and Disadvantages of Acute and Chronic Poisons

Acute	Chronic
<p>I. <u>Advantages</u></p> <ol style="list-style-type: none"> <li>1. Fast kill</li> <li>2. Dead bodies seen by user</li> <li>3. Effective where anticoagulant resistance is a problem</li> <li>4. Relative small amounts of bait required per kill</li> </ol>	<p>I. <u>Advantages</u></p> <ol style="list-style-type: none"> <li>1. Does not cause bait shyness</li> <li>2. Good control by in expert use</li> <li>3. Multi-dosing decreases possibility of accidental poisoning</li> <li>4. Palatable because of low concentration</li> <li>5. Very low concentration mean active ingredient cost per kg of bait is low</li> <li>6. Antidote very effective and practical</li> </ol>
<p>II. <u>Disadvantages</u></p> <ol style="list-style-type: none"> <li>1. Require pre-baiting to achieve practical control</li> <li>2. Cause bait shyness</li> <li>3. Even where a few antidotes exists, time to give them is short</li> <li>4. Relatively high concentrations required making active ingredient cost per kg of formulation high</li> <li>5. High concentrations required can lead to unpalatability</li> <li>6. Poor selectivity-high hazard to non-target species</li> <li>7. Formulation options restricted almost entirely to baits</li> </ol>	<p>II. <u>Disadvantages</u></p> <ol style="list-style-type: none"> <li>1. Bodies generally not seen (die under cover)</li> <li>2. Tend to be non-selective</li> <li>3. Slow to act; dominant rodents may eat several lethal doses; wasteful and may increase secondary poisoning hazard</li> <li>4. Relatively large amount of bait required per rodent kill and can lead to under baiting</li> <li>5. Anticoagulant resistance</li> </ol>

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moisture contents, the particle size and porosity of the soil. Sandy soils may render fumigants virtually ineffective. Commonly used fumigants are aluminium phosphide, hydrogen cyanide, methyl bromide, carbon sulphide and carbon monoxide. The characteristics of common rodent fumigants are listed in Table 4.

#### 4. CHEMOSTERILANTS

These are mostly organic compounds which temporarily or permanently sterilize the male or female rats. Rodents in general are prolific breeders and one fertile male rat can breed with dozens of female rats. Therefore a partial reduction in the fertile male population has no effect upon reproduction. Keeping in view of this problem a combination of toxic and sterility effect is desired in a compound which can be used effectively.

Epibloc is both an acute toxicant as well as a male sterilant agent (non-reversible sterility), beside killing it also prevent the passage of sperms in male rats.

#### IDEAL RODENTICIDE

The following are the desirable factors which should be present in a rodenticide and be kept in mind during planning and operation of any rodent control campaigns:

1. It should produce painless death
2. Readily degraded (only in dead animals or in the crop fields)
3. Odourless and tasteless
4. Can be easily counteracted with a perfect antidote
5. Slow acting
6. It should not create bait-shyness
7. This should not cause resistance or immunity to develop
8. They should possess high re-acceptance property
9. In baits they should have long half-life
10. In-expensive

#### BAIT FORMULATIONS

Rodenticidal baits in which the active ingredient is mixed with an edible base are the most generally effective and widely used means of controlling rodents. Various aspects of the bait formulation require consideration including the edible bait base, the rodenticide and the use of bait additives.

Table 4: Some Characteristics of Rodent Fumigants

Fumigant	Chemical Structure	Molec. Wgt.	Physio-logic. Action	LD50 (Rat) mg/lit.	Inflam-able	Heavier than air
Hydrogen cyanide	HCN	27	CA	0.04	Yes	No
Carbon monoxide	CO	28	CA	(0.35% Conc.)	No	No
Hydrogen phosphide	H <sub>3</sub> P	34	I	0.8	Yes	Yes
Carbon dioxide	CO <sub>2</sub>	44	SA	(20-30% Conc.)	No	Yes
Sulfur dioxide	SO <sub>2</sub>	64	I	1.6	No	Yes
Methyl bromide	CH <sub>3</sub> Br	95	I	3.6	No	Yes
Chloro-picrin	CCl <sub>3</sub> NO <sub>2</sub>	164	I	2.0	No	Yes

CA = Chemical asphyxiant

I = Irritant

SA = Simple asphyxiant

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## 1. BAIT BASES

The bait base makes up the largest proportion of the bait and should be selected on the basis of its high preference to the target species, ready availability and acceptable cost.

All of the cereal grains commonly grown in Pakistan can be used as rat baits. Tests in many countries and under free choice situations have shown that maize is the best bait material, closely followed by oats. Then comes rice, then wheat. Normally, any good quality cereal is suitable and may be chosen according to local availability and cost. Very often, specially for use on arable land and where food is in short supply, poorer quality materials such as bran or middlings may be satisfactory. However, it is usually necessary to use a higher quality bait to compete with the attractions of rodent's regular diet in places such as food stores and grain fields near harvest time.

Preparation of grain for use as bait is another important factor for success. Maize must be cracked or crushed to the size of wheat or rice grains. Oats must be rolled or crimped and wheat should be crushed lightly or cracked. Only rice, easily available in the market in the broken form, need no special processing and it is reasonable in price and always available. The reason for the cracking, crushing or rolling of grains is to aid in the adherence of the poison and/or its mixing in the bait.

## 2. ADHERENTS FOR RODENTICIDES OR BINDERS

It is normally desirable to include a binder such as an edible oil in most bait formulations. The binder serves two main purposes.

a. Where the bait base contains coarse particles such as whole grains, the binder assists in maintaining a uniform dispersion of the rodenticide in the bait and prevent it from settling down.

b. The binder greatly increases the safety of bait mixing by suppressing the evolution of a toxic dust during the mixing operation.

The most frequently used binders, are water, vegetable oil and paraffin wax. Edible oil tend to increase the palatability of the bait slightly and water increases to markedly. Paraffin

wax gives the bait partial protection against attack by insects and mould and prevents it from being washed away by rain but tend to reduce palatability.

### 3. ATTRACTANTS

Apart from oil and water, only sugar at a concentration of about 5% is well established in improving the palatability of bait to commensal rodents. It does, however, increase the susceptibility of bait to attack by ants. Additives, such as molasses, meat meal or fish meal are not generally found to increase the attractiveness of bait.

### 4. BAIT PRESERVATIVES

Paranitrophenol at 0.25% or dehydroacetic acid at 0.1% may be useful to stop bait going mouldy in the warm, humid conditions. As they reduce the palatability of bait some what, they should not be used unless experience has shown that they are necessary.

### 5. COLOURED DYES

Coloured dyes or pigments for rodent baits are recommended because:

- a. To protect seed eating birds (aversion to certain colours).
- b. Prevent possible human and livestock accident.
- c. Aid in bait identification when stored and in the field.
- d. Aid in bait mixing to assure thorough mixing.

Both oil and water soluble dyes are added to the baits such as blue, nigrosene black, fast green, lampblack and dark pink.

## PREPARATION OF BAIT

### 1. CALCULATING THE BAIT FORMULA

a. When using a technical ingredient, such as zinc phosphide (100%), calculations are straight forward. To prepare a 2% concentration of finished bait, simply add 2 kg of zinc phosphide to 98 kg of bait ingredients.

b. When using concentrates, the rule to remember is to divide the percent of the concentrate by the final concentration desired. The answer obtained will be the total number of parts of bait ingredients needed. Simply subtract one part for the concentrate and the remainder will be the bait ingredients.

Example: (i) a 0.5% concentrate, final mix to be 0.025%  
 $0.5/0.025 = 20$

Mix 1 part concentrate with 19 parts bait

(ii) Racumin a 0.75% concentrate final mix to contain 0.0375%

$0.75/0.0375 = 20$

Mix 1 part concentrate with 19 parts bait.

## 2. METHODS

We will discuss the methods of preparation of zinc phosphide and Racumin baits as these are only acute and anticoagulant registered poisons available in the market.

a. The proportion of the 2% zinc phosphide rat-cake are:

- 48% flour (atta)
- 48% broken rice or wheat or maize
- 2% zinc phosphide
- 2% cooking oil (vegetable oil)

A sample formula for field use is:

- 2.5 kg flour
- 2.5 kg rice, wheat or corn
- 200 gm edible oil
- 125 gm zinc phosphide (being marketed in Pakistan by Jaffer Brothers, contain 80% active ingredients)
- Plus enough water to make a stiff dough

i) In a clean container, bucket or mixer, place the flour and grain and mix well.

ii) Add the zinc phosphide to the mixed dry ingredients, mix until the mixture is an even grey color.

- iii) Add the edible oil and mix well
- iv) Slowly add the water and mix until a stiff batter is formed.
- v) Place the bait on a smooth surface and roll flat till one centimeter thick. A wooden form and a piece of pipe or round wood can be used to ensure rapid rolling and uniform thickness.
- vi) Then using a knife, cut the flattened bait into squares about the size of a five paisa coin.
- vii) Place in the sun to dry for 2-3 days, turning occasionally. Protect from dew and rain.
- viii) Store in a cool dry place by packing in plastic bags. The sequence of mixing the bait is very important. Zinc phosphide reacts slowly with water to release the poison gas, phosphine. By adding the oil to the dry grain and zinc phosphide mix, the oil coats the zinc phosphide particles and reduces the water's contact with the poison.

b. Racumin: To prepare a Racumin bait use fairly clean broken rice, cracked wheat or cracked maize. Place 19 parts of the grain in a clean container for mixing. Add just enough edible or cooking oil to lightly coat the grain. When the two are mixed, continue stirring whilst slowly adding one part of the Racumin master mix, a light blue powder. Mix till the grain is evenly coated.

## BAIT PLACEMENT TECHNIQUES

### 1. PADDY

In paddy the treatment of the fields begin 3-5 weeks after the nursery plantation. Loose grain baits of anticoagulants packed in polythene bags (100 gm) or the PVC pipe permanent bait stations are placed on the field dikes or bunds after every 15 m. When field size is 0.4 ha. or one, bait half way along each bund and one every intersection between bunds, when field size is smaller, the average distance between bait points is kept about 10 m. Treatments with three weeks intervals are made, replenishing the first treatment after 3-4 days and the third treatment being done about 2 weeks before harvest.

The polythene bags of permanent bait stations give the bait adequate protection from the rain and dew. Each anticoagulant bait point in the field is marked by fixing a number flagged stick in the soil. This makes easy the successive treatments at the fixed bait points.

"Rat cake" bait of zinc phosphide or other acute poisons are applied on the bunds, 2-3 pieces at each bait point place-ment procedure and time table is the same as in case of anticoagulants.

## 2. WHEAT

Baiting can be conducted on the fields about 6-8 weeks after sowing. Anticoagulant baits are applied on the bunds halfway along each bund and one on the intersection of the bunds. Because of rodent burrow activity inside the fields the baiting is done inside as shown in Fig. 1 and 2. Treatments are

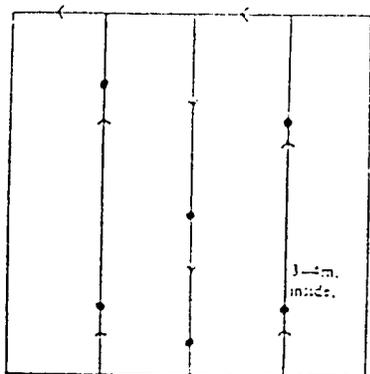


Fig. 1: Spot baiting inside the fields with Zinc Phosphide at Wheat Flowering Time.

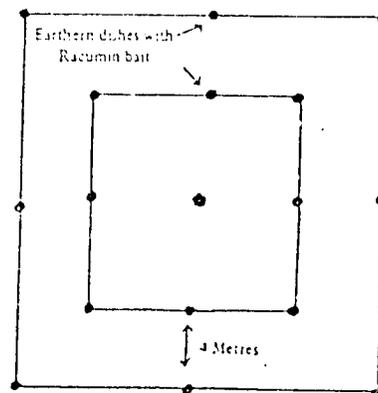


Fig. 2: Placement of Racumin bait inside the fields and along the bunds.

made with one month interval and bait replenished where it is required. "Rat cake" bait of zinc phosphide and other acute poison is applied on the field bunds after 15 m interval or halfway along each field bunds and at every intersection of bunds and then making a transect inside the plots. The active and open burrows are treated along the baiting lines.

### 3. SUGARCANE

Baiting in the sugarcane fields is carried out almost the same way as in wheat plots except that only one baiting line instead of three is established in the middle of the field.

### RODENT CONTROL IN SHOPS AND GODOWNS

In godowns where heavy rodent infestations are recorded use 5 or 10% zinc phosphide tracking powder to knock down the population quickly. This tracking powder should be used inside protective wooden bait stations or asbestos pipe bait stations (45 cm long, 10 cm diameter). These bait stations are placed along the walls at an interval of 10-15 m. If the godown is big, place these bait stations in the middle of the godowns beside the concrete pillars. This operation is conducted for 3-4 days only and then the zinc phosphide powder is replaced by 0.75% Racumin tracking powder. Tracking powder of zinc phosphide can be made easily by mixing it thoroughly with Fullers' earth (Multani mitti).

Damp baits such as fruits, are attractive to rats even when they refuse dry grain baits, but deteriorate quickly.

As most godown rats need water to drink, the water soluble anticoagulant bait has proved successful. From Chemdyes Ltd. Racumin 8.0% pre-solution is available from which ready liquid bait can be made. Use in automatic poultry water drinker. Place them after 10-15 m. Check them after every 2-3 days and replenish.

### RODENT CONTROL IN POULTRY FARMS

The rat infestations on the poultry farms can be controlled or excluded by making sheds rat proof, using traps and improving sanitational conditions.

Zinc phosphide bait can be used in the protected bait stations and place these stations along the walls with 15-20 m intervals. Later on the same bait station can be used for Racumin baiting. Tracking powders of zinc phosphide and Racumin can also be used as described in "Rodent control in shops and godowns".

## 1. FUMIGATION

The most effective way of controlling porcupines is to locate an occupied den and fumigating this to kill the occupant. Insert 10-15 tablets in active den with the help of long handled shovel which is then packed with brushwood or vegetation and sealed firmly with dirt. A new burrow or one in hard stony soil may require only 5-10 tablets while the old and deep burrows need 15 tablets.

A two-ingredient pyrotechnic device has been successfully evaluated in Pakistan. This device is simply a gas cartridge containing 65% by weight of sodium nitrate and 35% grinded charcoal. Devices weighing 200-250 gm of ingredient can give 80-95% reduction of porcupines. After igniting, the device is placed deep into the burrow. The burrow is sealed with brushwood and dirt. As a result of burning, carbon monoxide is released which kills the animal.

The same techniques of fumigation is effective for control of mole rat, Nesokia indica. One tablet of phostoxin is used for each live burrow and size of cartridge is about 50 gm.

## 2. BAITING

Baiting with strychnine and sodium monofluoroacetate(1080) using potatoes and apples results into quick kill. Very minor quantity of these poisons at the end of a thin stick is smeared on cut potatoes and apples and then placed deep into the burrow in the evening.

Permanent bait stations with strychnine treated (5.65%) salt blacks can be used in forest areas effectively.

## WILD BOAR CONTROL

Wild boar must be fed on untreated bait material for at least 4 nights to overcome their threshold of avoidance. Get them used to feeding at a particular site and to concentrate their numbers. The poison site must be chosen near a trail that is being currently used by wild boar.

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## 1. ACUTE POISON

1080 Sodium fluoroacetate can be used. Follow the following basic principles:

- a. Begin the programme with a free feeding using unpoisoned baits.
- b. Unpoisoned bait feeding should continue for a period varying from 4 days to 14 days. This depends upon seasonal conditions and availability of natural food.
- c. Lay the poison bait (0.03%) [wheat flour bait balls + 2% molasses] at a time when maximum level of free baiting is reached i.e. when all the pigs are drawn out from their hide-outs in a given target area.
- d. Use the same bait base by which the pre-baiting has done.
- e. The baiting programme should be started at a time when the pigs are living in stressful situation looking for food and water.

## 2. CHRONIC POISONS

Racumin, warfarin and brodifacoum are chronic poisons. The bait concentrations for the said poisons should be 0.025%, 0.025% and 0.005% respectively. Use wheat flour as bait base. Add 2% molasses and water. Make the balls of approximately 100 gm weight. Coat each bait ball with full cream dry milk before placing. Use this bait for 7 days consecutively and increase the bait amount as the consumption increases, there is no need of prebaiting.

## BIRD CONTROL

### 1. AVITROL

Avitrol (4-Aminopyridine) is used as a frightening repellent. Birds eating the treated bait become disoriented, give out distress calls, exhibit erratic flights, tremors and convulsions before death. Distress calls usually begin about 15 minutes and lasts 20-30 minutes. The effected birds frighten the other birds in the flock and causing them to leave the area. Avitrol is used at a 3% concentration on the treated grain

(cracked corn) and treated grains are then diluted with 99 parts of untreated cracked corn.

## 2. METHIOCARB

Methiocarb (3, 3-Dimethyl 4- (Methyl thio) phenyl methyl carbamate) is a chemical used to reduce bird damage to wheat, rice and maize. It causes physiological distress which results in avoidance of treated food. Methiocarb is applied as seed dressing to wheat, rice and maize at 0.25% concentration.

### GENERAL SAFETY PRECAUTIONS

1. No eating, drinking or smoking should take place when poison baits are handled.
2. All cuts and abrasions on the hands and arms should be covered before starting work.
3. During the preparation of poison bait, protective clothing, impermeable gloves and, if necessary a dust mask should be worn, non-disposable gloves need to be washed with soap and hot water after use.
4. Poison bait should be prepared in a well-ventilated room designated for that purpose only, and care should be taken not to breath in or absorb any poison.
5. All poisons (pure chemicals, concentrates and prepared bait) should be clearly labelled POISON and held in a locked cabinet in a room which should also be kept locked when not in use.
6. Containers with poisonous contents should be clearly labelled with the name of the active ingredient, its concentration and empty containers should be disposed off.
7. When poison baits are laid, the occupier of the land or premises should be told their whereabouts - so that children, livestock and pets can be kept away.
8. A record should be kept of numbers and location of baiting posts.
9. After treatment all uneaten poison bait should be picked up; any dead animal should be burned or deeply buried.

10. Fumigation must always be done by a team of two people one to open the fumigant container, and then quickly close it after the fumigant has been drawn.
11. The applicator should always stand upward of the fumigation site so that the fumes blow away from him.
12. Stop fumigation if either party feels dizzy.
13. When accidental poisoning occur, an attempt should be made to induce vomiting until medical attention arrives.

## NON CHEMICAL CONTROL METHODS

### 1. HABITAT MANIPULATION

All wastes, edible should be correctly stored so that it does not provide harbourage or food and then adequately disposed off. All the materials should be stored on racks. To reduce cover, materials stored outside should be off the ground and not stacked against or near walls. In poultry operations, keep manure piles away from chicken houses.

### 2. RODENT PROOFING

buildings and food storage containers can be made rodent proof by ensuring no gap in the structure is more than 7 mm wide. Openings required to provide ventilation should have permanent screens fixed over them, made from metal mesh such as 6 mm, 24 gauge expanded metal, which should be painted to prevent rusting. Wooden doors should have fitting gauge galvanised iron sheet upto a height of approximately 30 cm on the outer surface of the door and frame.

### 3. CLEAN FARMING PRACTICE

On arable land, eliminate cover by cleaning nearby uncultivated areas of weeds, bushes or scrub including field edge habitats and the banks of ditches and other water courses. Efficient weed control during the growing season discourages the development of rodent infestation. In the post-harvest period it is important to eliminate crop trash i.e. by burning and to plough the field as soon as possible.

#### 4. TRAPPING

Different types of traps are available. Basically there are those that kill the animal upon being trapped, KILL OR SNAP-TRAPS, and traps in which the animal is caught alive, LIVE TRAPS (Fig. 3). Before setting traps ensure that they are

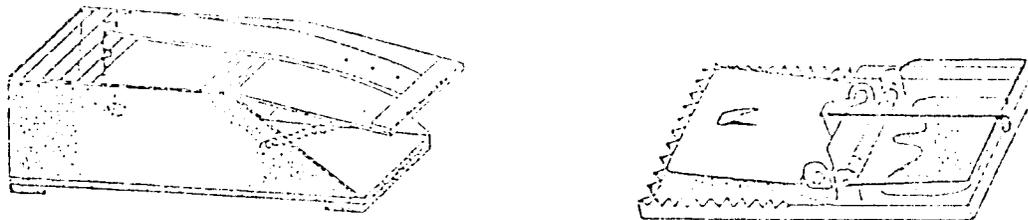


Fig. 3: Live and Kill Rat Traps

in good working order. Set traps so that are at right angles to the wall or other solid object, because rat prefer to run next to walls rather than across open spaces. Set traps late in the day and leave them overnight. Bait should be replenished at least once every 24 hours.

#### 5. SMOKING AND WATERING

Blow the smoke of chillies in to the burrow. Place the net on the burrow opening to prevent rat escaping. In some areas fields can be flooded to kill rats. In some instances, ditches can be made all around the field to protect crop. A trench of 1/2 m deep and 1/4 m wide will prevent most rodents from entering the field.

#### 6. WILD BOAR

The non-chemical methods for wild boar control involve pig sticking, hounding, netting, use of swine fever virus, electric fencing, use of explosives, trapping and shooting.

#### BIRD CONTROL

##### 1. TRAPPING

Pilot control trials have shown that a decoy trap based on modified Australian crow trap (MAC), which is proposed to call the PAROTRAP (Fig. 4) is effective in capturing live parakeets and sparrows in the field.

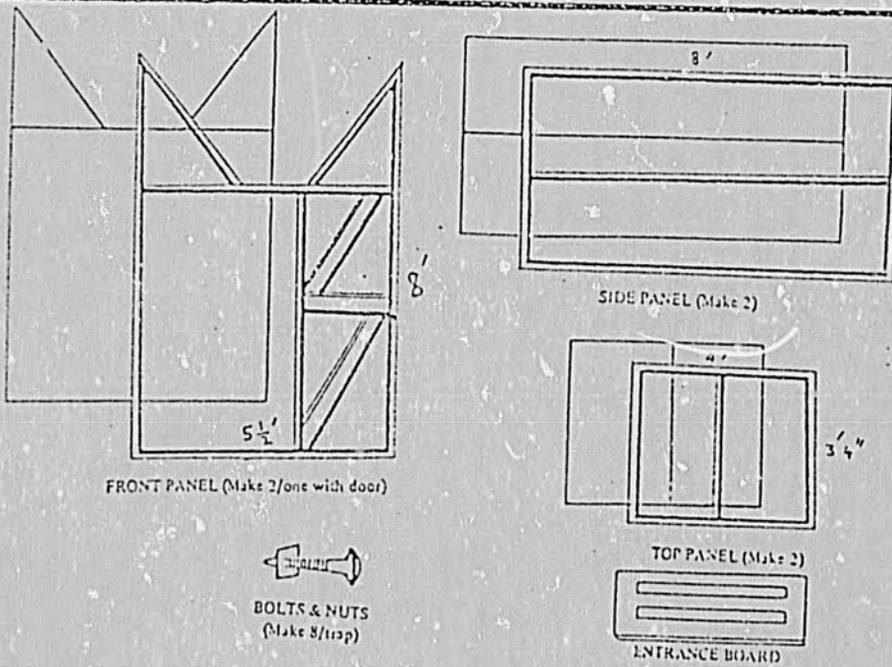
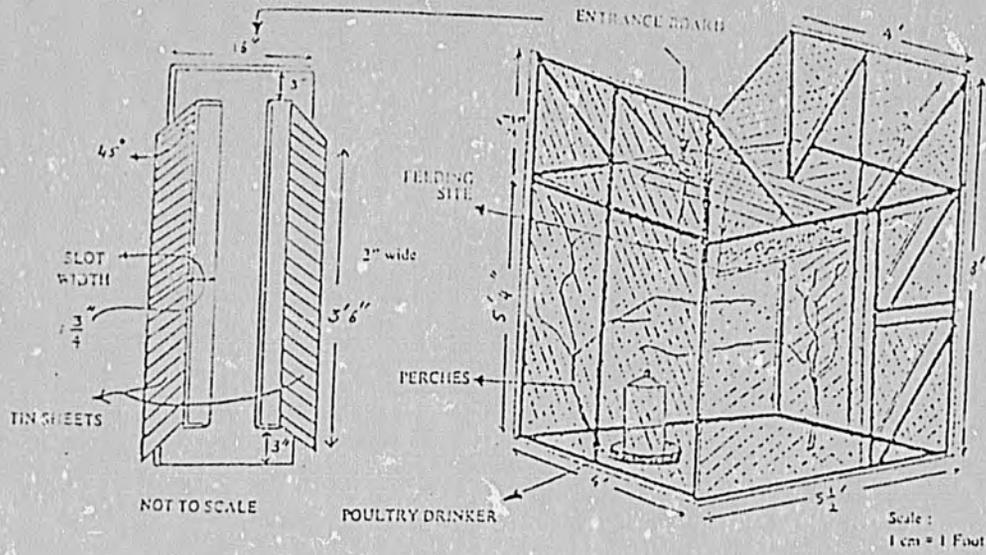


Fig. 4: Design of PAROTRAP

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Some adaptations are essential in the design of PAROTRAP which are as follows:

- a. The width of each longitudinal slot in the top entrance board should measure  $1 \frac{3}{4}$  inches for parakeets and  $1 \frac{1}{2}$  inches for house sparrows.
- b. The length of each slot should be shortened to measure 6 inches less (3 inches on each end) a difference which create a barrier to prevent parakeets from climbing their way out.
- c. Light gauge sheets of galvanized iron are cut into four strips, 6 inches wide. Two of these strips are fixed along the inner longitudinal length of the two out-most edges of the slots so that they hang vertically inside the trap at about  $45^\circ$  angle, and other two shorter pieces across the inner width. This deprives the entering parakeets from using their feet and hooked bills in climbing their way anywhere along the length of the slots.

## 2. NETTING

- a. Mist Net: Nets may be bought in various sizes and mesh sizes. For sparrow sized birds a mesh of  $1 \frac{1}{4}$  or  $1 \frac{1}{2}$  inches is suitable. Nets are attached to (4 m) long poles of bamboo, wood or metal (Fig. 5). It is most convenient to carry poles of light alloy, cut into short length (1.5 m) long that can be joined as required.

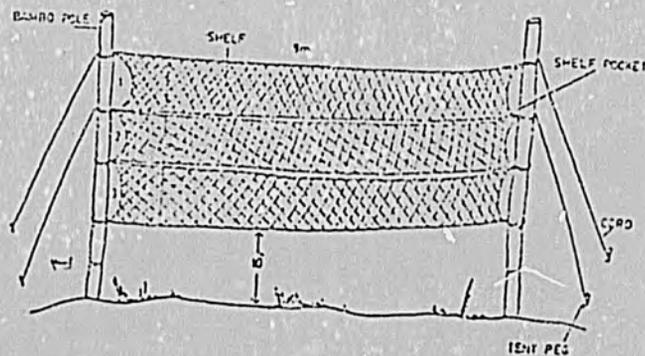


Fig. 5: Mist Net Setting

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b. Clap Net: In some situations, netting by using a local made clam-net (40 x 15 feet) equipped with a pull cord and provided with tethered decoy birds and a suitable bait can effectively reduce a local parakeet population. Provided that this method is being used before the onset of damage and throughout the ripening stage until harvest.

### 3. SCARING DEVICES

Useful scaring devices include the exploders, shell crackers, rockets, scare crows, broadcast alarms and distress calls and the most important, which is at experimental stage in Pakistan, is reflective tape.

### 4. REFLECTIVE TAPES

This tape is an elastic, transparent, synthetic resin film to which a silver metal layer is applied by vapor deposition, then coated with a coloured synthetic resin. In Pakistan local made tape is also available.

The tape reflect sunlight to produce a flashing effect and, when stretched, it pulsates and produces a loud humming or sometimes thunder - like noise in the wind. The tape is tied to the tallest heads of the crop or by creating the bamboo poles about one foot above the crop heads with a 5 m intervals perpendicular to the prevailing wind direction.

### SUMMARY

Good control of vertebrate pests can be achieved by employing chemical and non-chemical methods. The chemicals used in vertebrate pest control are classified as acute, chronic, fumigants, chemosterilants and avicides. Only two rodenticides i.e. zinc phosphide and Racumin are available in Pakistan. Effective rodent control can be made by using 2% zinc phosphide cake bait followed by 0.0375% Racumin loose grain bait. In godowns poison dust and liquid bait is recommended. In non-chemical rat control, kill and live trap furnish better results. For porcupine and short-tailed mole rat fumigation is a best method. Wild boar can be controlled by using 1080 (0.03%) or Racumin (0.025%) baits. Shooting is also considerable way to limit the wild boar and porcupine populations. For bird control two avicides; avitrol and methiocarb have been used in various countries. Trapping, netting and use of reflective tapes are good measures to save grain from birds both at pre- and post-

harvest stages. Habitat manipulation, rodent and bird proofing of buildings, clean farming practices, etc. are the precautionary measures to avoid the vertebrate pests.

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