ICAR

# RODENT NEWSLETTER

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## NATIONAL SYMPOSIUM ON RODENT PEST MANAGEMENT A SCENARIO FOR THE 21ST CENTURY (NOV. 15-16, 1991)

*SPONSORED BY*

ARID ZONE RESEARCH ASSOCIATION OF INDIA, JODHPUR

*ALL INDIA COORDINATED RESEARCH PROJECT ON RODENT CONTROL*

CENTRAL ARID ZONE RESEARCH INSTITUTE
JODHPUR-342 003

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## INTRODUCTION & OBJECTIVES

The losses due to rodent pests in crop production, processing, storage and transport need no emphasis. Besides this, rodents cause a number of diseases in human beings and in their pets. During the last two decades, various attempts have been made by the Government of India to streamline rodent research to evolve effective management technologies. Various research inputs through the ICAR, Universities and other research organisations have generated a good deal of information on this problem and on control methods. In the past, several rodent control campaigns have been organised by State and Central governments, though on a limited area basis. These have resulted in realisation of the magnitude of the rodent problem by the end users i.e. the farmers. However, the rodent control technologies could not achieve the desired results because of several constraints, viz., limited choice of rodenticides, non-availability of effective non chemical methods, the rodents' adaptation to changing habitats, and social taboos. The eighties have no doubt witnessed some revolution in rodent management technologies, viz. (i) development of second generation anticoagulant rodenticides which are quite effective with some degree of safety, (ii) improved bait formulations in the form of wax cakes and (iii) possibility of application of some non-chemical methods, like antifertility agents, improved traps and attractants like urine and pheromones. Side by side with these developments, the rodent problem is also getting complex due to changing land use patterns. The gradual spread of *Bandicota bengalensis* to newer areas is only one example of several such complexities. Recently rodents have been noticed to pose a serious threat to tele-communication system, airports and railways.

Considering these facts, the decade of the nineties is going to witness confrontations on sevenral fronts between man and the rodent and a somewhat clear picture of the scenario of the 21st century is likely to emerge. In order to review the ongoing rodent control research activities in crop fields, stored commodities, integrated management programmes and constraints analysis in transfer of technology, and to suggest future thrusts, a National Symposium on Rodent Pest Management - a scenario for the 21st Century was organised at the Central Arid Zone Research Institute on November 15 and 16, 1991.

# PROGRAMME

**15.11.1991**

9.00 AM — 9.45 AM — Registration

**Inaugural Session**

10.00 AM — Welcome by the Organising Secretary of the Symposium

Address by the Chairman, Dr. Ishwar Prakash, Professor of Eminence CAZRI Jodhpur

Vote of Thanks by Dr. K.R. Solanki, Secretary, Arid Zone Research Assoc. of India

10.45 AM — TEA BREAK

**Technical Session I**

11.15 AM - 1.00 PM — Chairman : Dr. Ishwar Prakash
Rapporteur : Dr. S. Chakraborty

**Theme** : Refinement of Rodent Control methods and transfer of RPM technologies-some challenges for the future.

Speaker : Dr. Ishwar Prakash, Professor of Eminence, CAZRI, Jodhpur.

1.00 PM - 2.30 PM — LUNCH BREAK

**Technical Session II**

2.30 PM - 5.00 PM — Chairman : Prof. V. P. Mittal
Rapporteur : Dr. A. Ranga Reddy

**Theme** : State-of-the-art technology for preventing major crop and grain losses due to rodents

Speakers : 1. Dr. V. R. Parshad, Professor, PAU, Ludhiana
2. Dr. Mrs. S. Sridhara, Assoc. Professor, Univ. of Agril. Sciences, Bangalore

**16.11.1991**

**Technical Session III**

9.30 AM - 11.00 AM — Chairman : Sri D. Srinath
Rapporteur : Nisha Patel



**Theme** : Innate and learned behavioual traits of rodents and their application in rodent management

Speaker : Dr. A. P. Jain, CAZRI, Jodhpur

11.00 AM - 11.30 AM — TEA BREAK

**Technical Session IV**

11.30 AM - 1.00 PM — Chairman : Prof. V. R. Parshad
Rapporteur : Dr. Mohd. Idris

**Theme** : Rodent control operations as a component of integrated pest management practices and the role of government agencies in rodent pest management

Speaker : Dr. AMK Mohana Rao, CPPTI, Hyderabad

1.00 PM - 2.30 PM — LUNCH BREAK

**Plenary Session**

2.30 PM - 5.00 PM — Chairman : Dr. R. L. Rajak
Rapporteur : Dr. P. K. Ghosh

Presentation of rapports by sessional rapporteurs

Adoption of recommendations of the Symposium

Release of book "Rodents in Indian Agriculture" — Dr. R. L. Rajak

Valedictory Address — Dr. R. L. Rajak

Vote of Thanks — Dr. P. K. Ghosh

# Refinement of rodent control methods and transfer of RPM technologies–Some challenges for the future

ISHWAR PRAKASH

Professor of Eminence,
Central Arid Zone Research Institute, Jodhpur

If the results of two or more methods for census of field rodents are compared, fairly wide differences will be observed. We have to refine our census methods to estimate the population density of field rodents in a more accurate manner. Likewise, rodent biologists are not of a uniform opinion about the threshold population number of commensal as well as field rodents in a hectare which should warrant initiation of control operations. This would naturally depend on the species as well as the crop or situation. For example, in a Five Star hotel, the existence of even one *Rattus rattus* may not be tolerated in deference to the hypersanitized sensitivities of the clientele but in the rice fields, a number of bandicoots may be allowed to stay because their control may not be cost effective. Again, in an oil palm plantation, even one rodent may be inflicting so much damage that it has to be removed. This aspect has another angle as well. The study of feeding behaviour has indicated that the acceptability of poison baits by most rodent species in the field declines significantly when a crop is standing. Hence the most suitable time for largescale rodent control operations is before sowing of the *kharif* or *rabi* crops. In such a situation the problem of determining the threshold level of rodent population becomes all the more important. I would consider it to be an important future line of research.

It has been observed in Haryana that rodents migrate away from the fields where poison baits are laid. During post control census these rodents are considered to be "controlled" whereas they are surviving outside the study area. It is necessary, therefore, that we enlarge the postcontrol census area. There is a need that experiments to determine the migratory behaviour of different rodent species, due to laying of poison baits, be taken up in a coordinated manner.

There are several questions to answer which we do not have well documented data generated through experimental trials in various situations covering rodent species of economic importance.

—Which method/sequence of control operation sustains a low order of rodent number for a longer duration : Zinc phosphide baiting followed by aluminum phosphide fumigation of burrows or zinc phosphide baiting followed by anticoagulant baiting, or the latter alone ?

—Which brings forth a superior control success-use of ready-to-use poison baits, freshly prepared baits or wax blocks ?

—Can we enhance the acceptability of poison baits ? Will researches on pheromones yield fruitful results ?

—Which is the "best" time for taking up field control operations?

—Which is the best mode of bait placement?

With the rapid expansion of developmental efforts all round the country, rodent damages to nonfood commodities have become increasingly pronounced, as in the aerodromes and in the telecommunication sector so that rodent biologists who have so far restricted their work to agriculture, must now expand their area of research to mitigate the losses inflicted by rodents in the new situations.

Snakes and certain birds are known to be the predators of rodents but very little quaantitative information is available on their predatory role. Ornithologists and herpetologists have studied the predatory birds and snakes from their own angles. Rodent biologists should study the same birds and snakes from a different angle with a view to work out if these predators can really impose an effective control on the population of different rodent species.

We have also to analyse and learn from the failures of extension efforts for rodent control and to understand why farmers are not adopting rodent control strategies on their own as much as they should do. We should also examine why even plant protection agencies do not include rodent control as an integral part of agricultural practices. One of the desirable strategies to adopt would be to revitalise the National Programme on Rodent Pest Management. There are three major components of this Programme : Apex Level Trainers' Training, taking up rodent control operations in farmers' fields and mass publicity through various media. This programme was launched jointly by the ICAR, the Plant Protection Directorate, the Agricultural Universities and the State Agricultural Departments. Another suggestion is to rejuvenate the Rodent Control Advisory Board which used to be chaired by the Honourable Union Minister of Agriculture. These steps are likely to help in evolving an Action Plan for undertaking effective rodent control operations throughout the country.

# State-of-the-art technology for preventing major crop and grain losses due to rodents–a scenario for the 21st century.

V. R. Parshad
Professor, AICRP on Rodent Control,
Department of Zoology, Punjab Agricultural University
Ludhiana

Bernard Dixon, while commenting on achievements of science in his famous book ' What is science for", has stated that "Even Norman Borlaug's green revolution is in question, blamed for everything from disturbing the economic pattern of agriculture in developing countries, to boosting the population of both men and grain consuming rats and encouraging the proliferation of insects". Enhanced food production by the use of improved and intensive agricultural technology has been the vital need of the world's 2/3 population living in developing countries. Increase in populations of rats and proliferation of insects are its implications which we have been tackling and which need to be tackled more effectively in future. In fact the green revolution is an expression of change from subsistence (natural) to intensive (managed) agricultural system which has enormous ecological implications. Of course, the subsistence farming system was self-regulating, self perpetuating and maintained natural flora and fauna while the intensive system is purely managed and has replaced the original communities of animals living in a steady state by more opportunistic species of insects and rodents. This situation is exemplified by a look at the mammalian wild life of Punjab which has put 95% of its total land into agriculture with maximum cropping intensity in the country. Larger wild life consisting of several species of deer and cat families has completely dwindled while the more opportunistic species of rodents proliferated during the last 30-40 years. These opportunistic species in fact influence our efforts in food production directly to a great extent and to feed 980 million people in India in the year 2000 and beyond we have to devise strategies, means and methods to tackle them more effectively. Through the ICAR's All India Coordinated Research Project on Rodent Control some practical data on the species, rodent ecology, behaviour and management of rodents have been generated and a good base for research and extension of rodent control technology has evolved and I am sure that from this take off stage we shall be able to



contribute much more effectively around the year 2000 and beyond. Research carried out at the AICRP centres on screening of rodenticides, methods and timings of their application, behavioural responses, breeding biology and reproductive and non toxic control methods of rodents certainly help us to feel optimistic that we shall be able to improve the technology of rodent pest management to boost our agricultural production further.

Estimates show that rodents reduce our food production to the tune of 10-12 million tonnes annually worth Rs. 2400 crores and this value for insect pests has been put to Rs. 6500 crores. Compared to the magnitude of the problem, our men and material inputs in the development and transfer of rodent control technology are quite inadequate, the total value of our existing spending on rodents may be less than 1% of what we are spending on insects. We as rodent researchers do not wish to be prejudiced against insects or other pests but certainly feel concerned with the rodent pest problem for which resources are far from satisfactory and this problem is rarely looked into with proper perspective. Of the total crop losses, it is being estimated that 45% is due to weeds, 20% due to diseases 35% due to insects and only 5% due to rodents, birds and other pests. Perspective with regard to rodents must be revised in order to enhance research and extension inputs as they should not be treated as minor or casual pests but are a major problem in food production and storage. FAO predicted that enhancement in food production by the year 2000 A.D. would occur 26% by expansion of the cultivated area, 14% by intensified cultivation sequnces and 60% by increasing crop yield. Improved plant protection is one of the most important factors considered for increasing the per acre yield. Studies in Punjab show that of the gap between actual and potential yield of crops, the rodent factor accounts for 11.8% in paddy, 12.4% in wheat and 22.4% in sugarcane.

With the above background in mind, I do not wish to talk about the details of the data and packages evolved for rodent pest management in India but would like to build a scenario of the situation and research and extension needs. It is astonishing that a country with 168.5 million ha arable agricultural land, handling about 180 million tonnes of food annually, uses only 850 tonnes of rodenticides: 350 tonnes of zinc phosphide, 500 tonnes of aluminium phosphide; the larger part of the latter is being used for some other purposes. This is inspite of the fact that rodents damage crops above the economic injury level in about 85% of the cropped area and there occurs a similar situation in houses and godowns.

A study of the use of pesticides ("World Pesticides" from Predicasts Inc. U.S.A.) predicted that world's consumption of rodenticides and fumigants in the year 1995 would be around 500,000 tonnes. At this rate it should be around 59625 tonnes for 168.5 million ha agricultural area and at the rate of 50 g/ha of zinc phosphide it comes to be 8425 tonnes. This is against 850 million tonnes in 1990 indicating that rodent control operations are being taken up as a token (just in 10-25% area) and do not match with the problem of rodents we have in agricultural fields and storages.

Rodent management strategies involve 3 basic approaches: (a) habitat alteration approach, (b) exclusion methods, and (c) killing by chemicals. Rat proofing, proper storage, sanitation, removal of weeds, proper size of dykes and bunds, cultivation measures, weeding, deep tillage, removal of rodent reservoirs are some of the habitat alterations methods which are practiced in one way or the other in different parts of the country. Problems related with monocultures, multiple cropping practices and timing of sowing the crops, methods of storages and handling the food grains need to be studied more thoroughly and some practices of management of rodents under such varied situations are expected to be evolved. Trapping and manual killing practices which have been adopted in different ways require drastic improvements and the need for a good and cheap trap and involvement of people in these methods is being greatly felt. Populations of predators have dwindled and probably we need to manage the predators as well in order to manage the rodent pest. I suggest that we should evolve a strong programme of managing both the pest and predator together and this needs extensive field studies of their interaction under the changing agro-ecosystems of the country.

Use of chemicals for rodent control have been the focus of our research work over the last 10-15 years, the fruits of this work hopefully would be harvested in the next few years. Two basic aproaches have been adopted in the use of rodenticides: (1) prophylactic treatment which breaks the natural cyclicity of rodents and prevents the growth of the local population before damages occur. Often this treatment is referred to as "lean period control" done in May-June in *Kharif* and Dec.-January in *rabi*. I must compliment Prof. Prakash for his wisdom in advocating this approch since long in the country and whereever the campaigns with this approach were carried out good success in rodent control has been recorded (2) symptomatic treatment, that is, to kill the rodent population which begins to threaten the crop or storage material. This is designed mainly to prevent the losses when the food actually becomes available in farms and



premises. Improved baiting and rodenticides which are accepted and are effective in the presence of alternate food sources need to be developed. Enormous data on the evaluation of bait carriers, second generation anticoagulants (brodifacoum, flocoumafen, bromadiolone, racumin, etc.) in laboratory and field situations has helped us to revise our practices to some extent and much more is being done and hopefully an effective and safe programme of rodent control with second generation anticoagulant rodenticides may become a reality in the near future.

Zinc phosphide was introduced for rodent control in 1911 and warfarin, the first generation anticoagulant rodenticide, in 1940. Warfarin could not gain popular acceptance in India as baiting with it requires long duration while zinc phosphide has been continuously used over a long period for rodent control. Even at present, in 80-90 per cent of rodent control operations zinc phosphide is being used. Zinc phosphide has certain advantages like being broad spectrum, versatile for bait formulation, rapidly detoxified in caracsses and baits, selective by protective to non-target species and being economical. Advantages overweigh its disadantages which include quick weatherability, bait shyness and incidental fatalities. Keeping in view the disadvantages the timing and method of baiting have been improved during the recent years. But because of its repeated multiple use and improper baits at the farmers' level, bait shyness in rodents against zinc phosphide baits has become a serious problem. Much research work has been carried out on the bait shyness problem and we hope to redesign our strategies of the use of zinc phosphide so as to reduce the incidence of bait shyness in field populations.

The second generation anticoagulant rodenticides namely brodifacoum, flocoumafen, bromadiolone, racumin etc have been shown to be effective against almost all species of Indian rodents and they have the following advantages : broad-spectrum of activity, effective at low doses and at short feeding periods, reported to have no poison bait shyness, prebaiting not required and are antidotable with vit. K. Data of AICRP centres have revealed that the ready-to-use wax bound cakes of these chemicals are relatively less preferred by rodents. For the application of second generation anticoagulants for rodent control in different situations, crops, premises, godowns, specific methods like the use of fresh grain bait, wax cakes, tracking powders need to be developed, depending upon the parameters of their acceptance by rodents, effectiveness and safety factors. However, I see a great scope of second generation anticoagulants in rodent control all over the world.

Whatever way the results of existing and future research take us to mould our strategies of rodent control in changing agroecosystems and socioeconomic perceptions of the country, the following qualifications for it must be stressed :

**1. Respect of life** - must adopt humane way of killing the pest

**2. Conservation oriented** - Protection to non-target species from direct and secondary poisoning (ground and predatory fauna)

**3. Safe and non hazardous** - extremely toxic non antidoteable chemicals be avoided (Ratol, AlP)

**4. Social acceptance** - effective and simple technology (e.g. warfarin).

**5. Cost - effective** - must be cheap

**6. Hygienic and environmetnal safety** - carcasses invite insects and infections and massive use of chemicals should be avoided (non-toxic methods)

**7. Genetic and behavioural responses** - should not cause resistance (warfarin) and behavioural selection (selection against bait shyness)

**8. Reduce resiliency** - ability of a population to absorb reduction in numbers.

Availability of resources in developed countries has given an opportunity to manufacturers of various types of electromagnetic and ultrasound equipment, complicated traps, inhumane glu-boards and other commercial devices that at best are less cost-effective than conventional control materials such as rodenticides and at their worst are making deliberate fraud, utilizing the wake of the environmental movement (Myllymaki, 1987). Costly and only wax cakes of second generation anticoagulant rodenticides seem to be a part of similar attitude. We need to and have to rely on strategies of the use of chemicals keeping in view the local ecological and scoio-economic conditions. In the past, extensive efforts have been made to evolve repellents and attractants for rodent control and much success could not be achieved, pre-umably because of the highly complex behaviour of rodents. Some breakthrough might occur during the next decade.

Rodent problem is in fact the problem of their high rate of reproduction. Evolution seems to have favoured rodents by providing them with high rate of reproduction, adaptability and dispersal. Life history strategies of rodents resemble those of r-strategy species and the package of management of r-strategies should be as given below.



**Management of r-strategy species**

| *Process* | *Technology* | *Status* |
|---|---|---|
| 1. High fecundity | 1. Chemosterilants | ∝chlorohydrin with sterilant-toxic properties, found effective against *B. bengalensis.* |
| | 2. Genetic sterility | No success recorded, work initiated at P.A.U. Ludhiana. |
| 2. Dispersal | 1. Environmental and cultural practices | Proofing, sanitation methods evolved and work on tilling, cropping patterns is in process. |
| | 2. Permanent baiting | Methods being evolved. |
| 3. Mortality | 1. Mechanical methods | Recommended. |
| | 2. Chemical methods | Some recommended and are a good base of screening of others. |
| | 3. Predators | Require more detailed studies. |

No single method of rodent control is 100% effective and use of a single method or chemical over a long period creates some ecological and behavioural complications as well as social disenchantment among the users of the technology. Research on all possible methods (chemical, environmental, biological, mechanical) of rodent pest management is being carried out and from results obtained so far, we are optimistic of achieving an effective, safe, acceptable technology under the varied economical and socio-economic conditions in India. Of course, the components of integrated pest management (IPM) would dominate our future strategies. All our efforts and expenditure on research on rodent control would be a waste if strenuous and sincere efforts in transfer of rodent control technology lags behind. However, our capabilities in this area surely would guide us from time to time to develop and improve the required technology and save millions of tonnes of food from rodents for human consumption.

# Rodent pest management in rice, plantation crops, horticultural crops and poultry

Dr. (Mrs) Shakunthala Sridhara
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University of Agricultural Sciences,
Bangalore

*Rodents in Rice*

Damage by rodents is one of the main factors for reduced yields throughout the rice growing regions of the world. Losses can be devastating during periodic outbreaks or chronically perpetual resulting in significant reductions. In fields, damage is uniformly distributed. Severe damage is evident when patches in the centre appear. It starts shortly after sowing, continues through milky stage to panicle development and ripening. Though imperfect, percent tiller cuts is the only reliable method of assessement which can be easily carried out by counting damaged tillers on diagonal lines across the field. The estimated damage from 1968 till date range from 0.5 to 60% in various states at different stages of crop growth and maturity. Hoarding losses range from 5 to 10%. Major species depredating are *Bandicota bengalensis*, *Mus booduga* and *Rattus meltada*. Minor pests are *Mus platythrix* and *Tatera indica*. Control strategies should be designed keeping in view the species involved, the eco-biology, behaviour, effective rodenticide, appropriate time of control, etc. Rodents can be controlled by biological, physical and chemical methods. Biological control includes use of predators like cats, snakes and pathogens as well as raising resistant varieties. Physical control comprises of habitat manipulation, (change in bund height, field size, weed control, growing repellent plants around the main crop), tribal methods (nets, snaring, luring, smoking, flooding, digging), electric fencing and trapping. Chemical control can be achieved using fumigants like aluminium phosphide, acute and chronic rodenticides. The range of population reduction achieved with these methods is from 61-93%. Combination of acute rodenticides followed by either aluminium phosphide fumigation or anticoagulant poisoning gave higher mortalities. Broken cereals, preferably those cultivated in the habitat of the target species with 5% groundnut or gingilly oil seem to be an ideal bait. All species exhibit bait shyness hence trapping/fumigation/anticoagulant treatment of bait shy population is a must. The future of rodent research should be directed towards establishing economic



threshold for control, home range, damage assessment at different stages of growth, habitat management, role of social behaviour in baiting success, destruction of rodents in lean period, the socio-economic status of farmers, training of extension personnel and farmers.

*Rodents in Plantation Crops*

Amongst plantation crops, coconuts are damaged from 3 month onwards by *R. r. wroughtoni* and *R. rattus rufescens* on the crown, by *B. bengalensis* in nursery, and by *B. indica* and *R. rattus* in storage (copra). Damage estimated is 9-30% to tender nuts, 8 to 50% to mature nuts and 6-8% in nursery. Mechanical control includes trapping and metal banding which are not very satisfactory. Habitat manipulation definitely reduces damage but reports on biological control using snakes and barn owls indicate limited success but offer great hope for the future. Chemical control with anticagulants have been limited to single evaluation with only no. of fallen, damaged nuts as the index of success. Second generation anticoagulants fared better than warfarin.

Sugarcane is attacked after 14 months at internodes. Losses range from 7.5 to 14%. Species inflicting damage are *B. bengalensis*, *R. meltada*, *Mus* Sp. Grid baiting with second generation anticoagulants gave better reduction. But infestation and control are greatly influenced by reservoir populations surrounding cane fields.

Cocoa is damaged by *R. rattus* and squirrels, and the damage ranges from 8-15%. Control measures include block hygiene, timely harvesting and anticoagulant baiting.

Oil palm is damaged upto 5-57.3% by different species of *Rattus* and by *R. r. wroughtoni* at seedling stage. Anticoagulants seem to keep populations down as well as predation by snakes.

Cardamom losses due to squirrels and *B. bengalensis* ranged from 8.7 to 12.6%. Trapping, cultural practices gave limited control. Anticoagulant treatment was unsatisfactory.

The other plantation crops reported to be damaged by rodents are rubber, cassava, arecanut, cashewnut, *ber*, plantation forestry, almond and tea.

In general, lacuna exists on population ecology, biology and behaviour of the species involved, effect of sustained baiting on yield and cost : benefit ratio.

*Horticultural Crops*

Reports on damage to vegetables is very scanty and range from 4.1 to 19.9%. The major species are *Tatera indica, B. bengalensis. B. indica R. rattus, Mus. booduga, Meriones hurrianae. R. meltada* squirrel and *Hystrix indica.* Only one serious study on cost-benefit ratio is available (Advani and Mathur, 1982). Although fruit damage by squirrels is widespread no attempt has been made to study this problem.

*Poultry*

Damage is by way of consumption of poultry feed, contamination of poultry feed, damage to eggs, chicks, structure, gunny bags, egg trays and transmission of disease. Species involved are *R. rattus, M. booduga B. indica and T. Indica.* Population peak was seen in summer, breeding peak in December. Ragi +5% groundnut oil was the best preferred bait. 1% $Zn_3P_2$ was most effective but induced bait shyness which extended to all the components of bait. Brodifacoum gave most effective mortality compared to bromadiolone trapping and zinc phosphide both in lab and in the field. The anticouaglant can be potentiated by ibuprofen and phenylbutazone. Rodenticide efficacy was influenced by season, poultry structure and poison used.



# Innate and learned behavioural traits of rodents and their application in rodent management

A. P. Jain

Central Arid Zone Research Institute,
Jodhpur

Although sufficient technologies are available to contain rodent menace a dent is yet to be made in their application. This may largely be attributed to our failure in imparting proper education and training at various strata. However, at research front too serious attempts are needed to explore and utilize information on various aspects of ethology-an area neglected so far especially in respect of systematic and in-depth studies at least on economically important rodent pests.

Behavioural patterns are the mechanisms which largely serve to maintain the organism and allow selective exploitation of a suitable microhabitat. The behavioural patterns as related to management may broadly be classified as:.

**I. Innate behaviour**

These are inborn and fixed, stereotyped traits which include grooming, feeding, breeding, etc.

**II. Learned behaviour**

These traits usually develop as a result of repeated exposures to a stimulus. Thus, these behavioural traits are strategies which are ultimate products of natural selections.

**III. Modified learned behaviour**

Certain learned traits get linked with the sex and are thus passed on to progenies by selective breeding. Development of resistance to first generation anticoagulant rodenticides by *Rattus* and *Mus* is an example of this nature.

Generally, the innate traits are displayed in part or in full in favourable environment. The avoidance or attraction are the ultimate products of learned traits. Display of such traits largely depends upon nature of stimulus; its intensity and exposure period etc. These traits are discussed below for Indian rodents and their plausible uses in managing them.

**Innate behavioural traits**

Some important traits are considered.

(i) **Grooming** : This trait is displayed by all the rodent species. It is exhibited in sequence but it could be complete or incomplete. The frequency of grooming also varies from juvenile to adult rodent. The species which groom frequently can be best managed by tracking powders.

(ii) **Feeding behaviour** : Present day rodent management is based on "feeding of poison baits". Therefore, feeding behaviour assumes prime importance. Various components of this behavioural trait relevant to management strategy are detailed below :.

(a) **Seedivore rodents** — Most of the field rodents are seedivores and therefore seeds are the best poisoning medium. Of course, field trials are also required to verify this. Besides these, size of seed/grain is also important for managing a species. The cranial structure of *Mus* species does not allow them to feed on big sized and very hard seed/grain. Therefore, laboratory and field trials are required to be conducted considering the physique of such species.

(b) **Solitary feeding v/s group feeding** — Certain species are solitary feeders (*Meriones hurrianae*) whereas others are group feeders (*Tatera indica* in Bikaner). Therefore, burrow baiting or use of bait stations can be adopted accordingly. Similar information on other species is reqired to be genreated.

(c) **Feeding time** — Rodents are expected to feed at the outset of initiating their routine activities but species like *Meriones hurrianae* may go for repairing their burrows. For such species placing of trap or baiting time is different than that for *Tatera indica* and *Rattus meltada* who do not repair their burrows so frequently as *M. hurrianae* does. Unless we have definite information on circadian rhythm of various species we can neither use traps nor baits effectively. For those species of rodents which usually shovel soil regularly from their burrows, the burrow baiting is problematic. Even if the traps are laid close to the mouths of burrow openings these would be filled with dug soil. Under such circumstances atleast a kick distance is to be maintained. So is the case with baits. These may also be thrown away by kick action. For such species, therefore, baits in the form of waxcakes be tried or a wire loop bait hanger should be employed.



(d) **Natural food v/s combinations of various components** — If the stomach contents are analysed throughout a year, the highest frequenting material may be used as the poisoning medium. This will also tell us whether that rodent species is a pest or not. However, we do have information on food preferences in the laboratory, yet preferences for such foods under field conditions are rarely studied. This may possibly affect the acceptance of baits. Further, it is also not necessary that food available in plenty in an area should be preferred by the rodents of that locality.

(e) **Hoarding behaviour** — Hoarding of food is observed in *B. bengalensis*, to some extent in *B. indica* and occasionally in *Tatera indica*. Such information is not available for other species.

(f) **Omnivory**—Often it is claimed that rodents are omnivorous. So far no data have been reported to support this behaviour. If a species is omnivorous then we have many alternate baits to lure it especially when the problem of bait shyness crops up.

(g) **Cannibal behaviour**—It is observed that most of the field rodents reveal this behaviour in the laboratory and more so when littering is done although vitamins, greens and surplus food supplies are provided. This could also occur probably due to the stress of captivity. However, we do not have any idea whether this behaviour is displayed in nature. If so to what extent, and under what circumstances ? This will help us in creating such situations which will enforce this behaviour as a simple means of management.

(h) **Response towards additives**—Various additives are being used in baits with no definite concentration. These are oils, sugar, salt, jaggery, dry fish, fresh prawns, garlic, onions, anise, essence etc. Increase in concentration of any of the additives beyond recommended concentration usually results into decreased consumption of bait. Experience suggests that except vegetable (edible) oils no other additive should be used.

**IV. Reproductive behavioural traits**

(a) **Semio-biology** : This field has opened vast avenues of hopes. Secretions/exudations of scent marking glands, prepuce glands, and vaginal wash of oestrous females when added to baits usually result in enhanced consumption. Even bait-shy rodents have fed on the same bait and poison. What needed is actual identification of the individual chemicals involved and ways and means of their artificial and natural sources of availability.

**(b) Pairing behaviour** : In cases of *Funambulus pennanti* and *M. hurrianae* usually a hot chase is given as a part of pairing or courtship behaviour, which sometimes ends in severe biting. Interestingly, in *M. hurrianae* the female is observed to forage while male is serving. Therefore, for such species burrow baiting may not prove effective as compared to scattered surface baitings. Such information is not available for other species. Diurnal species, however, mostly utilize visual cues during moon-light hours. Therefore, pairing behaviour may be related to lunar cycle. This needs to be investigated.

**(c) Parturition behaviour** : Whether it occurs in the presence of male or how does a mother protect her nest and litter from attacks of males and females of the same population, from different populations and other species etc. ? Whether cannibalism is prevalent at this stage or not ? We are ignorant on this aspect. Even if cannibalism occurs, what are the factors which induce this behavioural trait. These factors can be used to reduce the major chunk of population ready to be inducted.

**(d) Post natal development or neonatal behaviour**: Information on this aspect is very important because it is this period which determines the time when fresh recruits would influx into the population. Shorter the time of postnatal development quicker would be the recruitment and hence rapid would be the population growth. For many species this information is not available.

As observed in *Rattus meltada* the mother metad prepares small exit holes for young metads. Similarly, in *B. bengalensis* and *Nesokia indica* burrow openigs are normally kept closed. For burrow baiting or for fumigation these are required to be opened or de-plugged.

Weaning behaviour is yet another activity which is manifested in large population build up. For many species we do not know whether these young ones face hostile reactions from their own family members of either sex, other members of the population and members of other species especially when these venture out of parental burrows to establish their own homes.

**(e) Oestrous cycle**: Except for a very few species oestrous cycle has not been worked out. Information on this aspect is very important since short oestrous cycle generally denotes pregnancies in quick succession. Similarly information on superfoetation, superfecundity, pregnancy heat, actual heat period, postparturition heat period etc. is not available. These informations can be best utilised in introducing antifertility agents.



**Territorial behaviour**

This behaviour is conspicuous in diurnal rodents but during breeding season the territories overlap. Therefore, for such species bait points can be scattered during breeding season. But for many species, especially for nocturnal species we do not have any informaion on this aspect.

**Marking behaviour**

Detailed studies are only available on *Meriones* sp. Urine, faeces, sebum, and other biochemicals are used to mark the area and objects. These biochemicals convey different signals. So far a few well defined signals have been identified which include ready to mate status, territoriality, identification of objects/routes etc. If these complex biochemical substances are applied on bait containers and traps then problems like neophobia could be minimised.

It must be cautioned at this juncture that these biochemical substances induce very complex and intricate behavioural responses and it is not necessary that these may reflect similar manifestations at all times. Drumming or thumping of hind foot is very common in *M. hurrianae*, but it is totally absent in solitary *M. hurrianae*. Therefore, in depth studies are warranted in respect of use of urine, sebum and other allied chemicals.

**Genetic engineering**

If somehow sterile genes could be identified within the natural populations, the same could be raised artificially and introduced in rodents on a large scale to register a natural check.

**V. Communication behavioural traits**

These behavioural traits are really very important and we have no knowledge on this aspect in Indian rodents.

**(a) Tactile commnnications** : So far nothing is known about this trait. How and what does an animal communicate when it meets with a young, adult, and opposite sex animal of the same family, other members of the same population, and all the members of other species ? It may be mentioned that tactile communication is totally different from chemical communication.

**(b) Visual communication** : Postures convey various acts like threatening, aggression, alarming, submission, lordosis etc. These acts are yet to be

studied in many rodent species. Visual communications are more conspicuous in diurnal rodents. But for nocturnal species it may not be very effective except that black or white tassel of hairs on the tip of tails of gerbils may be used as orientation point for males when engaged in sexual pursuits. These studies are likely to convey which species is more aggressive so that its spread and invasion in newer territories could be checked in time.

(*c*) *Auditory communication :*

1. **Vocal**—By passing air through the glottis sounds of various wave lengths are produced. So far, we do not have perfect information on sounds like distress call, mating call, alarming call, warning call, challenge call, etc. which can be effectively used in management strategies.

2. **Non-vocal**—Such sounds are generally produced by activities of rodents like their movements, digging, kick-back throw of dug soil, grinding of incisors, teeth-chattering. If these sounds are recorded for a very aggressive species and replayed in an area of submissive species a migration of the submissive species can be induced. Further, if cage-traps are laid in that locality increased tendency of trapping of submissive rodents would occur as these traps would serve as ideal safe spots. These are just speculations but they can be tried.

**Learned behavioural traits**

Here, harmful stimuli are perceived fast and are displayed in avoidance behaviour. However, the degree, intensity and period of exposure to that stimulus are very important, crucial and determinent factors which ultimately manifest into avoidance behaviour. Desert gerbils have hypertrophied tympanic bullae to differentiate wing beats of harmful and raptorial birds, to perceive sounds of snake movements, etc.

So is the case with bait shyness. Its development and persistence against zinc phosphide varies from 15 days in *Gerbillus gleadowi* to 474 days in B. *bengalensis*.

**Factors inducing learning traits**

Mainly two key factors are obviously involved : (a) food supplies and (b) availability of space/shelter.

(a) *Food dependant learning traits :*

i. In West Bengal and Bangladesh the large bandicoot rat (*B. indica*) has learnt to feed upon molluses and snails. They have also developed a technique to break open the shells. But it does not necessarily mean that



sea food can be used as baiting medium. Experience on *Rattus rattus* inhabiting poultry farms suggested that these rats preferred cereals over poultry feed to which they were acclimated.

ii. **Bait shyness behaviour and its appraisal**—This is a sort of safety learning from the harmful effects of poisons. It is revealed by almost all economically important rodent species. The degree and intensity of this behaviour largely depends upon concentration of poison used, interval of exposure of same bait and the poison. Even rodents develop shyness to individual components of the poison bait.

Failure or non-acceptance of bromadiolone bait after zinc phosphide baiting is probably the repercussion of bait shyness behaviour. Bromadiolone is wheat based bait and if wheat is used in zinc phosphide baiting then there is every likelihood of rejection of bromadiolone bait. Moreover, either in bait or elsewhere in diet if rodents happen to consume protein over 10 per cent the efficacy of zinc phosphide is reduced. Similarly for anticoagulant baits if rodents are feeding on greens the mortality rates are reduced as compared to those feeding on dry cereals. Thus anticoagulants can prove more effective during dry seasons and in arid zone ecosystems. So the anticoagulants may not be useful to contain rodent menace during vegetative growth of many crops on which rodents are feeding. However, this requires to be experimentally verified.

(b) *Space dependent learning traits :*

1. **Exploratory learning :** By regular exploration of the newer areas rodents learn to select better niches. *B. bengalensis* has thus learnt to be a sewer rat in Bombay, whereas it is a godown rat in Howrah and further infiltrating major railway stations all over India.

2. **Induced learning :** Sometimes human activities create ample opportunities for field rodents to become commensal ones. Initially these rodents live as pseudo-commensals but with passage of time they become true commensals. Constructions of houses on the habitats of rodents due to rapid urbanisation induces the field rodents to opt for commensalism. Field rodents of Rajasthan and Gujarat (gerbils and rock-rats) are often trapped from houses, poultry farms and godowns. *Tatera indica* has already become commensal in Bikaner town.

3. **Forced learning**

i. *Through human activity*-In jhum cultivation of NEH region rodents are forced to leave their natural habitat when jungles are cleared and set on fires. Thus, rodents of this area migrate to nearby cropped areas.

ii. *Through climatic vagaries :*

(a) *Monsoon rains*—Migration of *B. bengalensis* from crop fields to houses in eastern U.P. during monsoon period due to inundation of area is observed. Bandicoots tide over this difficult period by finding temporary shelter in the houses. As the water recedes they again migrate to crop fields.

(b) *Summers*—Entry of *Nesokia indica* from Punjab to Rajasthan desert through Sri Ganganagar made them to become completely subterranean rodents in Bikaner and Nagaur districts. During hot summer days these mole rats are unable to come out for foraging etc. So they make very deep (1m and more) and extensive burrows. At such depths only roots are available as food. For better survival these rats started selecting trees which have large number of roots with little wood. Unfortunately root bark of such trees (*Prosopis juliflora* and *Acacia tortilis*) had good amount of tannins. These rats quickly learnt to remove the bark and use it as a plug for burrows. They feed only upon the cortical portion. Further, the free roaming rodents of Punjab became so much cautious for survival that they do not accept any trap or bait but only the roots of living trees. It is very difficult to manage *Nesokia indica* because of this behaviour.

**Food and space interdependent learning traits**

*Rattus rattus* (House rat) is basically a commensal rodent throughout the world but its various sub-species occupy altogether different habitats which are food and space interdependent. *R. r. rufescens* is distributed in houses, *R. r. wroughtoni* resides in coconut plantation, *R. r. brunneusculus* abodes in shifting (Jhum) cultivation, etc.

**Convergent evolution of behavioural traits**

In most of the deserts of Africa, America and India spiders and scorpions occupy the top of the food chain. The behaviour of rodents in dealing with and feeding on them is same irrespective of species and desert. This convergent evolution of behavioural trait is indicative of the fact that under similar prevailing conditions the behaviour of rodents could be predicted irrespective of place and species. But unless and until we have indepth studies on the complex and intricate behavioural responses of individuals of free living populations of mixed rodent species towards our tools of management strategies probably the rodent problem shall remain as it is today.



# Rodent control operations as a component of integrated pest management practices and the role of government agencies in rodent pest management.

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## ABSTRACT

Integrated Pest Management (IPM) is a strategy blending various control techniques in an integral fashion, making maximum use of natural mortality factors and need based specific control measures. Thus it is a system, in the context of the associated environment and the population dynamics of the pest species, utilises all suitable techniques and methods in a compatible way and maintains pest populations at levels below the economic injury level. IPM is also relevant to the control of rodents as is applicable to all other pests. Most of the farmers with serious rodent damage problems make some efforts to control with not much success in the efforts. No single method of rodent control is applicable to all pest situations, and even under the most ideal conditions the results of most control methods are somewhat variable. As a result the rodents should be controlled integrating various control methods and agents so that the control activity is effective, economic, ecologically justifiable and takes climatic and local conditions into account.

While planning the integrated methods of approach for rodent control, environmental manipulation and rodenticide application are required to be considered coupled with appropriate time and proper application. These should be considered as complementary rather than alternative approaches. While working out the planning processes for IPM approach, adequate technical, economical and sociological informations of the proposed area/State are required for the decision makers. The technical information should include components of diverse environment around, since rodents may move between the components of the system viz., rice fields to coconut to sugarcane to wheat fields to adjoining farm houses etc. One of the major constraints in implementing the IPM approaches would be individual approach by the farmers restricting rodent control to their cultivated farmlands, ignoring a blatant fact that rodents are highly mobile and immigrate to farm lands with more carrying capacity. As such, a community approach incorporating rodent control as one of the

steps in the overall ambit of farm practices is required to be inculcated in the farmers' minds.

Though not i n an IPM approach, efforts are being made by various State and Central Governments to control rodents in the farm lands and at storage as per the requirement. The ICAR launched a National Programme on rodent pest management from 1976 in collaboration with Central Directorate of Plant Protection. Ministry of Food and States/UTs. This programme has three major components - preparation of community, training and evaluating package of practices and is primarily aimed to undertake rodent control at the community level. This programme is required to be revitalised in order to translate these components to an action plan. Rodents are included in various Centrally sponsored schemes envisaged by Union Ministries of Agriculture and Food and thus financial assistance is extended to the States/UTs.

Stricter exercise of powers vested with the State Governments is required for enforcing rodent control measures, which have been incorporated under the relevant licensing Rules governing foodgrain dealers and mills. The Ministry of Food launched the "Save Grain Campaign" which popularises rodent control at farmers' level through training programmes, demonstrations, publicity and financial assistance to States/UTs for the construction of new rodent proof storage structures and rodent proofing of traditional storage structures. Some of the States/UTs have their own schemes to contain the rodent problem and the need. Quality rodenticides are also being made available through pesticide outlets. In spite of all these efforts, successful rodent control can be achieved only by motivation and mass mobilisation of manpower, and inputs at appropriate time with the village as a unit in an IPM framework.



## Recommendations of the Symposium

The following recommendations emerged after detailed deliberations :

1. Location specific recommendations for rodent pest management to be brought out by the Project Coordinator, All India Coordinated Research Project on Rodent Control, CAZRI, Jodhpur based on the investigations carried out by the AICRP (RC) Cooperating Centres and other Institutions in the country for the benefit of extension workers.

2. Data on the cropwise losses due to rodents to be compiled by the Project Coordinator, AICRP on Rodent Control as per the field investigations conducted in the country.

3. The composition of the existing Expert Committee on Rodent Control may be expanded to have representations from the Railways, the Airport authorities, the Health departments, the Forest departments and other organisations where intensive rodent control operations are required to be taken up regularly.

4. The twenty five central Integrated Pest Management Centres operating under the Central Directorate of Plant Protection and Quarantine should popularise the adoption of Integrated Rodent Pest Management practices.

5. The National Programme on Rodent Pest Management should be revived.

6. Apex Level Training Courses on Rodent Pest Management have been conducted for some years in the past at CAZRI, Jodhpur, CPPTI, Hyderabad in collaboration with APAU, Hyderabad and IGSI, Hapur. The ICAR Research Complex for NEH Region, Shillong has also been identified as a training centre. These trainings could be revived immediately.

7. Training for the identified officers on Integrated Rodent Pest Management should be organised at CPPTI, Hyderabad. The Project Coordinator, ICAR shall request scientists working under the Project to

assist as resource persons in imparting this training. The central Directorate of Plant Protection should send a formal request to this effect.

8. It was proposed to organise a two day meeting in New Delhi, during February 1992, by the Project Coordinator to streamline and modify the protocols for data generation on population census, loss assessment and on bioeffectiveness of rodenticides.

9. The Plant Protection Adviser may address letters to States-Union Territories advising them on the need to ensure that extension functionaries may give more emphasis on :

(i) Identifying nodal officers for coordinating rodent control activities.

(ii) Proper adoption of recommended package of rodent control techniques by farmers and making available antidotes at strategic points near the end user level.

(iii) Earmarking separate budget for rodent control under the 'PP Head'.

10. A review of the merits and limitations of registered, provisionally registered and prospective candidate rodenticides was done. It was observed/ recommended that :

i) Safety of zinc phosphide could be improved by adoption of improved formulation techniques. It was reported by the Industry that already they are in the process of adopting improved formulations technology and they shall be submitting an application for granting registration of the said formulation to the Central Directorate of Plant Protection.

ii)Barium carbonate and warfarin, though registered, have become obsolete and there is no demand for these, nor are the registrants manufacturing them. Moreover, with the introduction of newer single dose anticoagulants the requirement/production of other registered multiple dose anticoagulants (warfarin and coumachlor) has become negligible.

iii) Brodifacoum and Flocoumafen are the prospective candidate chemicals which have been screened in our country for their rodenticidal property. These have been reported to be effective. Plant Protection Adviser may review the data generation with the concerned manufacturers to ascertain the position regarding submission of applications for grant of registration.



11. The rodent menace in Railways, particularly on the railway tracks where optical cables are used and also at the Airports was discussed. It was suggested that Plant Protection Advisor may discuss with the concerned officers of these Departments/Ministries about rodent problem, the steps being taken to contain them and the need for any technical guidance to overcome the problem.

12. It was recommended that steps should be taken for combating the rodent menace in stored agricultural commodities and the Ministry of Food be requested to take up the matter with the Nodal Departments in various States/Union Territories for intensifying their efforts.

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The help kindly extended by Dr. J. V. Ramanna Rao, Director, Defence Laboratory, Jodhpur, in making stay arrangements for the participants and in other matters was most valuable, and we thank him and his colleagues very sincerely. We are indebted to the Heads of different research organizations and Vice-Chancellors of Agricultural Universities for deputing rodent workers to participate in the symposium. It is needless to say that the active participation of these scientists has been the single most important contributory factor for the success of the symposium.

Dr. R.L. Rajak, Plant Protection Adviser to the Government of India, had not only conceded our request to come to Jodhpur to deliver the valedictory address at the Plenary Session, his enthusiastic and positive interactions with the participants was easily the most prominent highlight of the Symposium. The Plant Protection Adviser had also kindly released, at the end of his address, a new book titled "Rodents in Indian Agriculture", edited by Ishwar Prakash and P.K. Ghosh. We cannot thank Dr. Rajak sufficiently for hist most valuable inputs to the organization of the Symposium.

We thank to Dr. N.L. Joshi, Officer-in-Charge, CAZRI Guest House and Hostel, for taking meticulous care of our participants' needs. It is a

pleasure to record our deep appreciation of the excellent catering and other services rendered by Shri Raj Singh and his staff at the Guest House.

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Vijaylaxmi Sales Corporation, Jaipur
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M.W. Enterprises, New Delhi
National Organic Chemical Industries Limited (Agrochemicals Division), Bombay
Scientific Publishers, Jodhpur.

It is needless to say how much we have valued their support and our very genuine thanks go to all of them.

Last, but not the least. our colleagues at CAZRI and especially in the Division of Animal Sciences and Rodent Control, have given their best for the success of the Symposium. We will not try to thank by name all those who helped, lest we may leave out some names inadvertently. But we, nevertheless, express our gratitude for the help that we received on this occasion from our numerous colleagues at CAZRI.

**P.K. Ghosh**
Organising Secretary



## Report on VIIth Group Meeting, AICRP on Rodent Control

The VIIth Group Meeting of rodent scientists working under the AICRP on Rodent Control was held at CAZRI, Jodhpur on November 13 and 14, 1991. The meeting discussed the progress of ongoing research projects and identified some new areas of research to be taken up by the AICRP Centres during the next two years. The discussion in the Group Meeting led to several recommendations in regards to research and extension on rodent control. Some of the major recommendatios of the AICRP (RC) Group Meeting are as follows :

### 1. Revitalising the National Programme

It was decided that as suggesed by the QRT for AICRP on Rodent Control, the National Programme for Rodent Pest Management launched by AICRP (RC) in collaboration with the Plant Protection Directorate should be revived, revitalised and given impetus by the Council.

### 2. Exchange of APRs and Reports

It was decided that a month before the Workshop/Group Meeting starts, the reports of all centres should be exchanged/circulated among all centres so that the discussions at the Workshop are more purposeful/ meaningful. The Project Coordinator should also receive at least 5 copies from each centre.

The Project Coordinator shall write to the Directors of ICAR institutes and Vice Chancellors or Directors of Research of agricultural universities for according permission to the concerned scientists to visit other centres.

### 3. Uniform methodology for rodent census and damage assessment

The Officers inharge of all the AICRP centres will meet in New Delhi in February 1992 to finalize/formulate a uniform methodology for rodent census and damage assessment.

### 4. Research on predators

Preliminary data on the status of various predators on rodents in different regions will be collected at Punjab Agricultural University, Ludhiana and University of Agricultural Sciences, Bangalore. These two

centres will submit two projects to the ICAR seeking additional funds. There should be adequate numbers of Research Fellows for the projects.

5. **Developing package of practices**

The centres where adequate technologies for rodent management in specific crops have been developed will bring out technology bulletins of the same. The various centres which were assigned this job are :

| *Centre* | *Crop* |
|---|---|
| University of Agricultural Sciences, Bangalore | Rice |
| Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur | Soyabaan<br>Pulses |
| Gujarat Agricultural University, Junagadh | Groundnut |
| Punjab Agricultural University, Ludhiana | Wheat |
| ICAR Research Complex for NEH Region, Barapani, Shillong | Rodents in NEH Region and their management |

6. **Use of indigenous devices**

All the centres will take the details of the indigenous fumigation equipment developed by the AICRP centre at Andhra Pradesh Agricultural University, Maruteru and test it at their centre and make suitable modifications, if required.

7. **Training programme**

The future format, centres and number of training programmes to be organised will be finalized after discussion with the Plant Protection Adviser to the Government of India.

8. **Inclusion of other centres in the Workshops/Group Meetings**

It was decided that the Principal Investigators of the centres funded under the AP Cess fund programmes should also be included in group meetings/workshops.

Contributions for inclusion in the Newsletter may please be forwarded along with 1-2 good black and white photographs to :

Project Coordinator,
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