RESEARCH HIGHLIGHTS

1993-94

INDIAN COUNCIL OF AGRICULTURAL RESEARCH
NEW DELHI - 110 001

ALL INDIA CO-ORDINATED RESEARCH PROJECT
ON
RODENT CONTROL

CENTRAL ARID ZONE RESEARCH INSTITUTE
JODHPUR-342 003

Technical Bulletin No. 4

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PREFACE

This document embodies Research highlights of the All India Coordinated Research Project on Rodent Control for the year 1993-94. The Scientists of all the cooperating centres, which are spread in major agroclimatic zones of the country, have conducted extensive studies on various aspects of rodents research to elvove a viable rodent pest management system for different crops. The programmes allotted during the VIII Group Meeting of the AICRP held at CAZRI, Jodhpur, during November 1991, were carried out by these centres. I earnestly hope that the salient findings of the Project, presented in this Report would prove useful not only to the researchers engaged in agricultural rodentology but also to the planners and extension agencies engaged in transfer of technology programmes.

I take this opportunity to thank the Indian Council of Agricultural Research, New Delhi for funding the AICRP liberally and for its further extension during the VIII Five Year Plan. Sincere thanks are also due to the Director, Central Arid Zone Research Institute, Jodhpur for guidance and encouragemet for publishing the research highlights. I express my deep sense of gratitude to all my colleagues of AICRP whose scientific contributions and sincere cooperation have made it possible to bring out this Report in its present shape. My colleagues at CAZRI Jodhpur deserve special appreciation for their help and cooperation in preparation of the Report.

Jodhpur
22.07.1994

(B.D. RANA)
Project Coordinator
(Rodent Control)

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Project Coordinator's Report

It gives me immense pleasure to present the Research highlights of the All India Coordinated Research Project on Rodent Control for the year 1993-94. The Project has ten cooperating centres spread in all major agroclimatic zones of the country. Two more centres, at Hisar and Indore have been sanctioned during the Eighth Five Year Plan period. The Hisar Centre is entrusted to work on rodent management in vegetable crops, whereas Indore centre is to devote on soybean. Both the centres are SAU based and are likely to start functioning from next year. The contributions of the ten cooperating centres viz. Jodhpur, Ludhiana, Bangalore, Lucknow, Shiliong, Jabalpur, Maruteru, Junagadh and Solan are briefed as under :

The lesser bandicoot rat, *Bandicota bengalensis* continued to be the predominant rodent pest of Indian agriculture. However, it has not been reported in the crop fields surveys in Jodhpur, Bikaner and Pali districts of Arid Rajasthan. In the irrigated fields of Punjab, U.P. and Karnataka predominant species were *B. bengalensis*, *Tatera indica*, *Rattus meltada*, *Golunda ellioti* and *Mus* sp. The fruit orchards of apple, peach, pecan, plumes in Solan, Shimla, Kangra, Sirmour and Kinnaur districts in Himachal Pradesh, were infested by *B. bengalensis* and *M. musculus*. In Madhya Pradesh, *R. meltada*, *B. bengalensis*, *Mus booduga* and *T. indica* were the key pests in the order of their occurrence. The north and northwest arid regions of Gujarat showed dominance of *T. indica*, *M. hurrianae* and *B. bengalensis*, whereas, in north and south Saurashtra *B. bengalensis* was major pest followed by *T. indica* and *M. musculus*. In Rajasthan the Indira Gandhi Canal Command areas under irrigation for five years, did not record and major change in the rodent species composition. In the rice growing areas of coastal Andhra Pradesh only two species viz., *B. bengalensis* and *M. booduga* were reported. However, in the coconut palms only *R. r. wrougtoni* was reported from Andhra Pradesh.

Studies on estimation of rodent damage were continued during 1993-94 also. Survey of wheat fields of 12 villages in Punjab revealed 2.02% rodent damage. This damage was to the tune of 10.35% in the fields near wet areas and Kangli wetland of Kapurthala district (Punjab). However, the crop suffered 2.1-17.14% damage in Gujarat. Rodent damage to rice was more when the crop is attacked during flowering stage in Andhra Pradesh. However, in NEH Region upland rice experienced (11.7%) lesser damage than the lowland rice (12.9%). The damage was comparatively more in terraced cultivation during ripening stage of crop. Ludhiana centre studied the effect of floods on rodent damage to rice crop in 12 villages. The study

revealed that flooded rice fields had lower population of rodents causing only 0.6% loss whereas it was about 4.0% in non-flooded fields. Jabalpur centre recorded 0.04-0.64% yield loss in Soybean due to field rodents. Similarly gram crop suffered maximum damage of 2.7% at podding and seed formation stage, however, in Gujarat gram crop recorded 2.3-7.8% rodent damage. Potato suffered a loss of 17.0 and 21.3 kg/ha in Sagar and Jabalpur districts of Madhya Pradesh. Survey of sugarcane fields in 9 villages of Punjab revealed 13.4% rodent damage resulting in a yield loss of 5.2% or 29 q/ha. However, microplot studies at [Lucknow on squirrel damage to 10 released varieties of sugarcane indicated 13.7% (COLK 8102) to 100% (COLK 7810) damage.

Groundnut, sorghum and pearl millet suffered 2.82-10.5, 2.56-4.01 and 2.3-10.1% rodent damage, respectively, in Gujarat. Maize crop was damaged to a tune of 7.5% in Barapani, Shillong. The vegetable crops, like cauliflower and peas recorded 4.6-13.26% and 3.2-6.7% rodent damage respectively in Himachal Pradesh whereas in NEH region 7.8% damage was noticed in cabbage. Among the horticultural crops, apple nursery suffered 10.3-23.5% rodent damage in Himachal Pradesh, whereas pineapple recorded mean damage of 8.53 per cent in Meghalaya. Of the 10 pomegranate varieties screened against rodents, *Funambulus pennanti*, *T. indica*, and *R. meltada* and bird, *Psittacula krameri*, Jalore seedless and khog registered least damage to ripe fruits (10-17%).

The variety of rice seeds and germination were found to effect the food preference behaviour of *B. bengalensis*. It was observed that this species preferred to feed on non-germinated seeds of IR 8 variety and germinated seeds of PR 103 more than other test varieties. Similarly, the preference for moist semolina and maize flour was 6.7 times more than the dry ones. In Andhra Pradesh, maximum immigration was recorded during early stage of crop growth. Average number of immigrated animals was 91.9 per acre. Breeding biology of this rodent in Godavari Delta (A.P.) indicated 7 breeding peaks in a year (three during *kharif* and 3 during *rabi* and one in summers) with an average litter size of young ones.

A toxicant cum sterilant, alpha-chlorohydrin was found effective for control of zinc phosphide bait shy *B. bengalensis* which suffered 60% mortality with single treatment of 0.5% alpha chlorohydrin bait. Of the 40% survivor males, 10% were permanently sterile while rest had reduced sperm counts and sperm motility. In wheat field, single treatment with alpha-chlorohydrin and zinc phosphide resulted in 67% and 83% control success, respectively, with corresponding incidence of 2.9 and 2.2% damage at the maturity of the crop in contrast to 5.7% damage in the reference fields.

A small compact burrow fumigator was developed by APAU, Hyderabad Maruteru centre for the control of field rodents. The fumigator works with the help

of hand blower with a hollow cylindrical pipe of 8" and dia. of 10". It has a long G.I. pipe of 3.8" dia. It utilises agricultural wastes, like paddy straw which is burnt in the cylinder. The smoke is pushed into the burrow tunnels with the help of blower. Within 10-15 minutes, the rodents die of suffocation. The cost of the equipment is Rs. 400/- which may be purchased by marginal farmers.

Trapping for one year and cultural control methods could yield a rodent control success of 60 and 30%, respectively, in Himachal Pradesh, whereas, in Karnataka, trapping of rodents in poultry farms resulted in 20% success in rainy season and 75% success in winter and summer months.

Evaluation programmes of several rodenticides was also continued in laboratory and fields. Zinc phosphide (2%) wax blocks could yield only 40% mortality of *Funambulus pennanti* in Rajasthan, whereas, its freshly prepared loose bait resulted in over 70% kill of squirrels. Thermocole pieces proved to be an effective baiting medium for preparing zinc phosphide poison bait. Cholecalciferol, a vitamin D_3 based rodenticide proved effective against a variety of rodents. In no choice tests at Bangalore and Barapani, is yielded cent per cent kill of *B. bengalensis* whereas, in choice test at Bangalore, mortality was reduced to 40-60% with a death period of 8-10 days. In case of *T. indica* this rodenticide resulted in 80% mortality in no choice. In general, the cereal baits of cholecalciferol were more preferred by these species over its ready to use pellets or wax cake baits.

Racumin, an anticoagulant rodenticide, used as tracking powder (0.75%) showed cent per cent mortality of house rats in Barapani, and *R. meltada* and *T. indica* in Bangalore, whereas in Jodhpur, *Mus musculus* recorded only 50% mortality with the tracking powder treatment. In a comparative laboratory trial with cakes of bromadiolone against *R. rattus*, *R. cutchicus*, *B. bengalensis* and *R. meltada* cent per cent mortality of test rodents was achieved, however, the death period was slightly lower with cholecaciferol (4-6 days) than bromadiolone (5.2-10.0 days).

These rodenticides were also evaluated in various crop fields for evolving a management system. Some of the significant results are :

(a) Manual throwing of bromadiclone cake @ 1 k/ha in a grid pattern in sugarcane fields proved effective in U.P. Two treatments of brodifacoum (0.005%) ready to use baits in sugarcane during November and February showed 53% less infestation of rodents in adjoining wheat fields in Punjab. Similarly in Gujarat two applications of bromadiolone cake at tillering and milking stage of wheat crop proved most effective is containing the rodent menace. The control success in fruit orchards of Solan was to the tune of 82.5% with single application of bromadiolone (0.0005%). Even, in plantation crops cent per cent rodent control success was achieved within 3 months of two baitings (September-Octo-

ber) of bromadiolone concentrate (0.25%) in the central delta of A.P. and the success was maintained for 6-7 months.

(b) Racumin, an anticoagulant was evaluated in wheat crops at maturity stage and yielded 50-60% rodent control success. In one of the simulated studies it was noticed that single run by *B. bengalensis* on racumin tracking powder produced 80% mortality of the bandicoots whereas similar treatment for *T. indica* yielded only 29% kill.

(c) Studies on field acceptability of different baits in Madhya Pradesh indicated that 2% zinc phosphide with moist wheat is more acceptable (12.5%) to field rodents than moist gram based poison baits (10%). Similarly, in rice crop at prematurity stage acceptability of 2% zinc phosphide was 65% in comparison to the bromadiolone (0.005%) wax cackes (10%).

(d) Among various rodenticidal trials in poultry farm of Karnataka, brodifacoum (0.005%) yielded highest rodent control success (65%) followed by bromadiolone (48%), rodafarin (43%) and zinc phosphide (41%). Regular trapping provided 51% rodent control success in this poultry farms.

(e) Studies at Ludhiana confirmed that the freshly prepared baits of second generation anticoagulant, flocoumafen are superior over the ready to use wax cakes. Behavioural analysis of *B. bengalensis* and *T. indica* against the two types of bait revealed that fresh baits were suitable for control of both the species, whereas ready to use cakes had limited potential for the control of *T. indica* only.

(f) Among the non-lethal management techniques for rodent pests in cardomom crops, treatment of neem oil at 1% and 4% showed significantly reduced capsule damage whereas fish oil and Bingo (a non-poisonous sticky substance) did not show any effectiveness.

(g) Single application of 2% zinc phosphide at pedding stage of gram crop resulted in significant reduction in pod damage (31.5/m^2) than at seed stage (48.8/wt).

(h) Field evaluation of rodenticides in ground nut and wheat crop in Gujarat indicated highest control success in term of damage and crop yield with bromadiolone cakes (0.005%) followed by cholecalciferol (0.005%), flocoumafen (0.005%) and zinc phosphide (2%).

The Social engineering activity on Rodent Control is one of the important components of the AICRP wherein, each centre adopts 2-3 villages as maintenance area, some villages as neglected and survey areas. In the maintenance area, training, education, field domonstrations etc. on rodent management are done under scientific

supervision. In the neglected area this activity is done once and then left for the farmers to undertake the rodent control work whereas in reference/survey area, no training, demonstration etc. is done under the scientific supervision and such area is used as control. These adopted villages are changed after every 3-5 years. This project was undertaken in the villages by five centres viz., Jodhpur, Ludhiana, Bangalore, Junagadh and Jabalpur whereas in NEH Region this activity was restricted to urban localities during this year.

The research work on plantation crops at CPCRI, Kasaragad Centre could not be accomplished during the year due to vacant scientific and senior technical positions.

Recommendations for rodent management in various farming systems were made by Jodhpur (arid crops), Ludhiana (irrigated crops), Junagadh (groundnut/wheat), Bangalore (dryland crops), Maruteru (Rice) and Jabalpur (gram).

The project coordinating cell of the AICRP published two technical bulletins (English and Hindi) and one report i.e. Fifteen Years of Coordinated Research in Rodent Control during the year 1993-94. Quarterly publication of Rodent Newsletter remained a regulur activity of the Project.

Central Arid Zone Research Institute, Jodhpur

1. **Rodent Survey** :—Survey of rodent pests is Indira Gandhi Canal command areas was conducted during *rabi* season at Bajju village, where the canal irrigation is being done since last five years. The cultivated fields situated at sandy humocks harboured *Meriones hurrianae* and *Tatera indica*, whereas, the surrounding barren humocks were inhabited by truely xeric species like *Gerbillus gleadowi* and *Meriones hurrianae*. No mesic or sub-mesic species was captured in this area.

2. **Rodent damage:**—The damage in pomegranate fruits due to vetebrate pest attack was higher this year as compared to that of last year. Amongst the ten cultivars of pomegrante, Bassein seedless was highly prone to vertebrates viz rodents (*Funambulus pennanti*, *Tatera indica* and *Rattus meltada*) and birds (*Psittaculla krameri* and *Pycynonotus cafer*) and recorded 52.5—86% damage to ripe fruits. The performance of the ten cultivars against these pests in decreasing order of damage was: Bassein seedless > GKVK—1 > Jodhpur red > P—23—23 > Ganesh > Dholka > P—26 > G—137 > Jalore seedless > Khog. In a simulated experiment, *T. indica* was found to cause 100% damage to 5-10 day old seedlings of eight summer vegetables, in laboratory. Rodents were recorded to reduce the plant stand at early stage of gram crop. The plant density in the Central portion of gram field was on an average 114.9/m^2, which was reduced to only 68.7m^2 in rodent infested peripheral zones of the field.

3. **Rodent management:**—Ready to use wax cake formulation of zinc-phosphide exposed to *F. pennanti* for one day yielded only 40% mortality which remained at the same level even after increasing the exposure period to 2-3 days. The acceptability of the wax baits of zinc phosphide was also lower in comparison to plain wax blocks in choice test. Laboratory evaluation of Racumin tracking powder (0.75%) produced 50 per cent mortality among house mouse *Mus musculus* population.

4. **Rodent behaviour** ***vis a vis*** **scent marking behaviour**:—Exposure of conspecific and interspeclfic sebum odours in five combinations to *Meriones hurrianae* indicated that this gerbil perceives not only the conspecific odour of ventral scent marking gland but also of another species which is not sympatric i.e. *Meriones unguiculatus*. Indian Mcrion gerbil perferred ($P < 0.05$) unisex odour even that of *M. unguiculatus*.

5. **Social Engineering activity on Rodent Control:**—An opinion survey was conducted in four adopted villages of Luni Panchayat Samati. After establishing a closelinkage, 20 farmers from each village were intervieved through structured schedules to understand their perception about rodent pests. The sample consisted of farmers belonging to the age groups up to 25 yrs. (5%); 26-50 yrs. (72.5%) and more than 50 yrs. (22.5%). Of the total respondants, 58.5% represented small and and marginal category of land holding. About 75% and 41% farmers opinied that rodents are serious problem in wheat and vegetables, crops respectively. According to the farmers tomato and onion were most and least prone vegetables crops to rodent attack.

Punjab Agricultural University, Ludhiana

In Punjab, the lesser Bandicoot rat, *Bandicota bengalensis* was found to be the most predominant in the wheat - paddy - sugarcane cropping system in which the populations of the other species viz , *Tatera indica*, *Rattus meltada*, *Golunda ellioti* and *Mus* spp. have further declined compared to previous years. In house and the poultry farms, *Rattus rattus* was the most abundant.

An improvod multicatch rat trap developed and recommended by the PAU centre has shown good acceptance by the farmers for trapping the commensal and the field species. In our experiments, this trap has shown good trapping efficacy for different rodent species.

Studies on the effect of floods on rodents abundance and damage in paddy fields have revealed that the flooded fields in districts of Ludhiana. Patiala, Kapurthala and Jalandhar had low population and 0.6% damage as compared to high rodent population and 3.9% damage in the non-flooded fields. About 8% non-flooded fields had 0% damage and 23% fields had damage more than 8%. Average rodent damage to paddy based on the survey of 12 villages was found to be 2.03%.

Survey of rodent damage in sugarcane in 9 villages revealed damage to 13.4% (4.2-27.6%) canes of which 1.3% had completely dried by maturity and 12.1% had partial damage. The partially damaged canes weighed 31.5% less than the healthy canes. This represented a yield loss of 5.2% (about 29 quintals/ha).

Mean rodent damage to wheat based on a survey of 12 villages was 2.02% (0-36.4%). Heavy damage (10-35%) was recorded in fields located in bet areas and in areas near to Kanjli wetland in Kapurthala district where *B: bengalensis* and *R. meltada* were predominant.

Variety of rice seeds and germination were found to effect the food preference behaviour of *B. bengalensis*. Using 3 forms (rice seed, rice and germnated rice seed and 4 varieties of rice (IR 8, PR 106, PR 103 and Punjab basmati 370) it was found that this species preferred to eat non germinated seeds of IR 8 and germinated seeds of PR 103 more than corresponding forms of the other varieties. Germinated seeds of PR 106 and IR 8 were preferred more than rice and non germinated seeds. Similarly, the preference of the *B. bengalensis* for semolina and maize flour were altered with addition of water as the maize flour with addition of water and sugar was eaten 6.7 times more than dry semolina. Addition of groundnut oil and sugar enhanced the bait preference of *Funambulus pennati*, whereas, the food flavours had no effect.

Thermocol pieces were found as the suitable materia for application of zinc phosphide using groundnut oil as adhesive for poisonin *B. bengalensis* and *R. rattus* in which it was 100% accepted in laboratory per trials and also in the field trials for burrow application in case of *B. bengalensis*.

Two rodenticidal treatments with ready to use brodifacum blocks in November and February in sugarcane fields resulted in 53% lessrodent burrows in the adjoining wheat fields suggesting that control of rodents insugarcane is important in checking their damage in adjoining crop fields. lusting of burrows of *B. bengalensis* during lean periods, in June and November, with racumin tracking powder resulted in 43.3 and 47.8% rodent control.

Single run by *B. bengaiensis* in a simulated runwa dusted with 0.375% racumin tracking powder resulted in its 10% mortality ompared to only 20% in case of *T. indica* and 0% in case of *R. rattus* Its appliation in mature wheat fields and scrub waste land with puff duster resulted in 50-0% control success.

Species specificity and previous feeding experience eected the behavioural responses of *B. bengalensis* and *T. indica* towards freshlyprepared and ready to use baits of flocoumafen; this behavioural analysis showd that fresh baits are suitable for control of both the species, whereas, ready to ıse cakes have limited potential for the control of *T. indica* only.

Treatment of rats at the peripheries of poultry farms isimportant where single application of zinc phosphide resulted in 65.7% reductionn rat population inside the hen houses.

Toxicant-sterilant, alpha-chlorohydrin, was found effetive for the control of zinc phosphide bait shy *B. bengaensis* which suffered 60% ıortality with a single treatment of 0.5% alpha-chlorohydrin bait. Of the 40% suvivor males 10% were permanently sterile while the other 30% had reduced sperm cocentration and sperm motility. Induction of sterility in males with 60 mg/kg dose ad no effect on exploratory and sexual behaviour of their own and female parters. Behaviour of the females was found related to the stage of their estrous cycle and the fertility status of the males had no effect.

Pairing of female *B. bengaensis* with normal fertile mals resulted in pregnancy in 41.6% females, whereas, the females paired with sterile males had no sign of pregnancy. Sterility in males showed reversal in 23% rats fter 5 weeks of alpha-chlorohydrin treatment but the litter size of their female prtners was drastically reduced.

In wheat fields, single treatment of rodents with alpha-chlorohydrin and zinc phosphide resulted in 67% and 83% mortality, respectively with corresponding incidence of 2.9% and 2 2% damage at the maturity of the crop in contrast to 5.7% damage in the reference fields.

Under the social engineering programme 50 farm families were adopted in two villages viz., Panjetan and Pirthipur. The farmers were trained and educated in methods of rodent control and the success of the control operations which was carried out with free supply of rodenticide (zinc phosphide) motivated them in adopting rodent control as a practice. To treat the residual population of rodents with bromadiolone the farmers showed their eagerness over the use of aluminium phosphide but this poison was not available to them for use at their own level.

University of Agricultural Sciences, Bangalore

I. Rodent Species composition studies in different agroclimatic zone of Karnatka.

i) The Southern Transitional Zone (ARS/Navile and Honnavlelle) : The studies initiated during 1991-92 showed the presence of *Rattus meltda, B. bengalensis* and *T. indica* and in summers only *Rattus meltada* were traped in crops fields of groundnut, paddy and cotton. Birds were also trapped in thesnap traps used in the study. Further work is in progress.

ii) The Coastal Zone : Studies were conducted at CPCRI, legional Station at Vittal (mid coastal zone) and at CPCRI, kidu seed form (Interic coastal zone) and also at Agricultural Research Station, Kankanady Ullal. The rop fields include Paddy, cashew and topioca etc. *Rattus rattus* (Wroughton) was predominant species in these areas. *Rattus rattus rufescens, funambulus, tristrtis, Tatera indica, Bandicota bengalensis,* and *Mus booduga* were among the othe common rodents found. *Rattus blanfordi* and *Vandeleuria oleracea* occured in esser proportions. Infestation and burrow systems of *Hystrix indica* were also observd.

II. Rodenticide evaluation Studies :

a) *Quintox* (Cholecalciferol 0.075%)

(i) Choice feeding tests : Given choice of cake, pellet/cereal bits : *B. bengalensis* preferred cereal > cake > pellet and *T. indica* preferredcereal > pellet > cake

(ii) *B. bengalensis* : Registered only 60% mortality with ean 10 days for mortality ; the range 6-15 days. Whereas *T. indica* reistered only 40% with mean 8.5 days the range being 7-10 days.

(iii) *No choice feeding test* : *Quintox pellet baits* : *B. bengalens* registered 100% mortality over 10.2 days mean, with 4-21 days range where as *T. indica* registered only 80% over 9.2 days mean with 7-12 days rage.

(iv) *Quintox pellet baits* : Both *B. bengalensis* and *T. indis* registered 100% mortality with 4.4 days mean, 3-6 being the range for *B. bengalensis* and with 6.6 days mean, 7-11 days being the range for *T. indis*, respectively.

(v) The intake of bait was 4.23 g/ day and active ingredient ć 1.18 mg/kg body wt. by *B. bengalensis* and the same figures for *T. indica* is 02 g/day and 0.49 mg/kg body weight.

(vi) *T. indica* did not register 100% mortality in all the tests conducted except for pellet baits in no choice tests. In, general, these rodents exhibit variations of less mortality towards "Quintox baits (both cake and pellet) in the presence of alternate food source.

b) Racumin

All the concentrations evaluated (0.05, 0.06, 0.075 and 0.097, 0.0975%) resulted in 100% mortality. The average daily intake was highest with 0.065% concentration of racumin in bait and the duration for death was also lowest. With increase in racumin concentration to 0.0975% the consumption of poison bait reduced and duration for death increased. Duration for death was longer with lower dose 0.05 and 0.06%. Hence 0.075% was considered optimal conc. of racumin considering the duration of death and poison intake of both *R. meltada* and *T. Indica*. Further in choice test on *R. meltada* though poison intake reduced considerably, the duration for death ranged from 5 to 8 days, choice tests on *R. meltada* and *T. indica* indicate existance of poison shyness in *R. meltada*.

III. Comparative evaluation of rodenticides and trapping for management of rodents In poultry:

1) Trapping was least successful during rainy season (20%) but increased during winter and summer season (75%).
2) *Zinc phosphide* was not effective recording only 36-47% reduction of rodents during different seasons.
3) *Rodafarin* was also less effective reducing pest populations from 33.3% to 49.6% during the different seasons of the year.
4) *Bromadiolone* reduced 56% pests during summer, 47 to 55% in rainy season and only 35-37% during winter.
5) *Brodifacoum* eliminated 60-67% rodents in rainy season, 57-68% in winter and 60-74% in summer.

The overall efficacy of the methods employed was brodifacoum (65%) trapping (51%) > bromadiolone (48%) > rodafarin (43%) zinc > phosphide (41%).

IV. Rodent Pest Management in Cardamom :

In order to avoid lethal control of rodents, certain materials were offered under natural conditions to elicit responses of rodents and to work out the feasibility of using them for the management of rodent pests. Neem oil was tested at 1 to 4%, significantly reduced number of capsule damaged in 'control'. Fish oil was also 1 to 4% but the damage to capsules did not decrease. Bingo, tested at a non-poisonous sticky substance also proved ineffective in reducing capsule, damage.

V. Social engineering activity on rodent control :

Social engineering activity was initiated in four *talukas* of Bngalore Rural District during *kharif* 1992-93. The villages were : 1) Hariharaura in Chikkaballapur *taluk* 2). Margondanahalli and Kasarghatta in Nelamangala *taluk* 3) Padarahalli in Ramanagara *taluk* 4) Basavanapalyain Magadi *tluk* (Table 1). Further these villages were already adopted by Extension Deprtment of our University for their lab to land programme and the able supervision and experience of each of the Extension guides in each of the above villages were used.

a. Success Highlights :

1. The results were very enthusiastic and overwhelming ad the control operations carried out registered a very high reduction in roent population in all the villages, Hariharapura (74%), Margondanahal (95%), Pada rahalli (100%) and Basavanapalya (90%).
2. The species involved were *Rattus meltada, Bandicota bengalens, Tatera indica* and *Mus booduga* in fields and *Rattus rattus* and *Bandicota inica* in houses.
3. As regards the awareness to different components of odent control operation such as species, burrows, infestation, rodenticies and control, operation Margondanahalli and Kasaraghatta showed high prcent of aware ness on all categories compared to other villages.

Table 1. Villages under Social Engineering Activity on rodent Control duriy *Kharif* 1993

Villages	No. of houses	Population		Area under cultivation (acres)	Mjor Crops
Hariharapura	44	240		112	Ragi, Groudnut, Redgram
Margondanahalli	54	160		137	Vegetables (Flowers
Kasaraghatta	27	90		116	Ragi, Paddy Redgram, Groundnut, Coconut.
Padarnahalli	200	800		425	Paddy, Rag Groundnut, Cowpea, Hoegram, Mulbery. Jowar.
Basavanapalya	60	300	Dry	160	Ragi, Jowar Groundnut,
			Wet	250	Paddy, Redgam, Greengram,
			Garden	15	Cowpea, Vegtables, Coconut.

4. Farmers were of the opinion that the present type of campaign on a community basis really benefitted them to the extent of 25-40% especially in groundnut crop. They also wanted to continue control campaign in future also.

b. This approach of Rodent Control on Community basis had a good successful impact.

1. The instrctions from the leaders to farmers that they will receive poison bait only they contribute bait materials was very effective in involving farmers.
2. Farmers fter contributing bait materials attended consequent meetings/ demonstrations on rodent control without fail.
3. The prebit and poisons bait mixture was collected meticulously by each farmer.
4. Since thearmers were doing the rodent control operation under the guidance of stff of AICRP on rodent control their interest was higher and were also curios about the results.
5. The instrction were that each farmer should come back and report on the control sucess made him to see the number of dead rodents by himself. This resulted inword by mouth publicity encouraging even farmers ignorant of the meetins and reluctant to adopt the technology from those who had already caried out rodent control operations.

J. N. Krishi Vishwa Vidyalaya, Jabalpur

1. **Survey of rodents :** Survey on rodent complex conducted under Rice-Wheat and Cotton-*Jower* zones of Jabalpur and Ujjain revealed the presence of *M. meltada*, *B. bengalensis*, *Mus booduga* and *T. indica*. Among the above mentioned species *M. meltada* and *B. bengalensis* were found common in all the surveyed areas. Monitoring of rodents at Jabalpur indicated the dominance of *M. meltada* over others in live catches. Studies on burrow characteristics of different rodents also revealed the larger activity of *M. meltada* and *B. bengalensis*.

2. **Extent of rodent damage :** (a) *Soybean* : (i) The field experiment on the extent of damage denoted the activity of rodents from seedling to harvesting stage of crop. The mean number of cut plants were 0.08/m^2 each at seedling and vegetative stages. The number of cut branches were 1.04 and 0.08/m^2 at vegetative and flowering stages, respectively. The average number of damaged pods at podding and seed stages were found to be 1.33 and 3.66/m^2. The estimated per cent yield loss due to field rodents ranged from 0.04 to 0.64% in soybean, grown, after gram crop. Total yield loss was 1.03%, and (ii) The studies carried out at farmer's fields at Ujjian and Narsinghpur locations denoted mean yield loss of 0.17 and 0.20%, respectively in light and medium black soils of these districts.

(b) *Gram* : The extent of rodent damage recorded in experimental field denoted the activlty of rodents at all the stages of crop. The branches were cut at all the stages. The highest damage was observed to the pods at seed formation stage. The results showed 0.02, 0.05, 0.09, 2.72, 2.77, 1.24 and 0.58% losses at seedling, vegetative, flowering, podding, seed formation, advance green and prematurity stages of crop.

3. **Evaluation of rodenticides :** The common rodenticides viz. zinc phosphide and bromadiolone were evaluated for their acceptability in crop fields. The acceptability of 2% Zinc phosphide (solid bait) and 0.005% bromadiolone (wax block) was recorded to be 65 and 10%, respectively at prematurity stage of rice crop, and (ii) The acceptability of 2% Zinc phosphide bait prepared with wheat and gram showed variability in wheat crop. When zinc phosphide was coated on wheat grains, the acceptability was 12.5% and with gram it was only 10%. Close observations made on the number of poison feeding grains, it was found that field rats consumed 1/4th of a grain to 8 grains wheat and 1/4th of a grain to 3 seeds of gram.

Bait acceptability in burrow : The placement of 2% zinc phosphide bait and Bromadiolone wax block at the entrance of burrows in wheat crop revealed 40.6 and 33.33% acceptability respectively aomng field rats.

4. **Burrowing activity in gram :** The burrowing activity was observed from seedling to harvesting stage of gram crop. The number of live burrows on the bunds varied from 2 to 26 at different stages of crop growth in approximately one hectare area. The activity of rats after vegetative stage was observed in crop canopy and this may be due to their requirements. After harvest the total number of apparent burrows were noted to be 52 in the field.

5. **Assessment of rodent damage :** The mean estimated losses to potato yield hoarding was 21.32 and 17.02 kg/ha in Jabalpur and Sagar districts, respectively. The studies undertaken at farmers' field crop denoted that rodents caused 80 kg loss in yield/ha in some pockets of Narsinghpur and Jabalpur districts.

6. **Social engineeing activity on rodent control :** The studies on rodent activity conducted under field condition in adopted villages showed 86.60 and 82.69% control success in manitenance and neglected area during summer (*Kharif*). In *rabi* season 40% control success was recorded in maintenance area. The formers were trained and made acquainted with the improved rodent control technology.

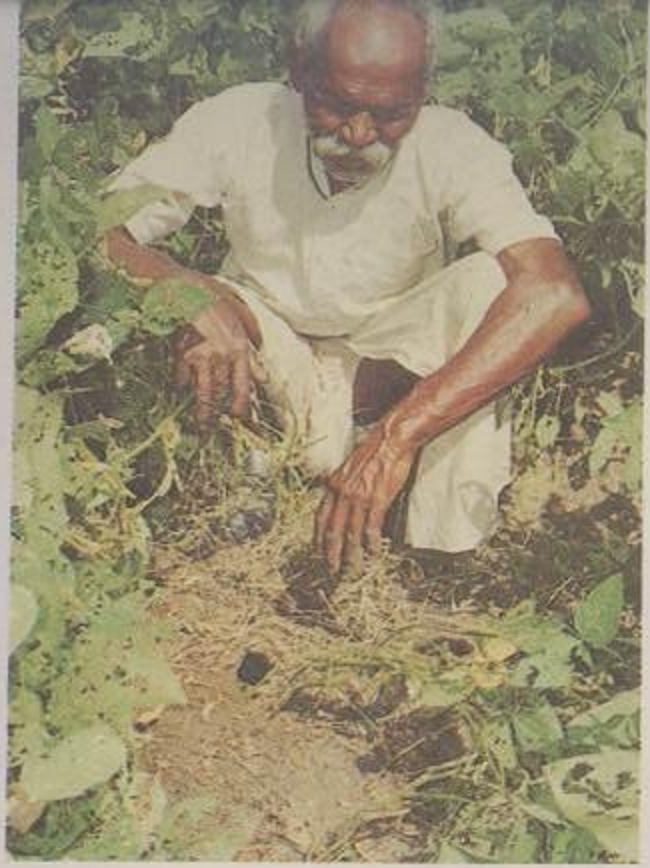
7. **Management of rodents in Poultry :** Studies carried out in the management of rodents in poultry showed that the treatment given with 2% zinc phosphide at monthly interval was found more effective than the treatment given at after two month interval in reducing the activity of rate in poultry. It was further found that activity of rodents more in poultry which situated near crop field as compnred to poultry away from it.

8. **Schedule for rodent management in gram :** Field experiment conducted for evolving the management schedule in gram showed that the single application of 2% zinc phosphide at pod stage gave significant reduction in the number of damaged pods (31.55 %) over the application done at seed stage (48.86) and control (65.66).

9. **Testing of plant product against Soft-furred field rat :** Cage experiment results revealed the ineffectiveness of *Ipomea* leaves' extract against *M. meltada*. Even after the poisoned seed feeding, no repellency was observed to plain food (wheat grains).

1. Breeding Pattern of *B. Bengalensis* in Godawari Elta —Three breeding peaks in one crop season

2. Bandicoot problem in paddy crop



3. Rodent Infestation in Soybean crop

4. *T. Indica* damaging the vegetable seedlings

5. Killing of *B. Bengalensis* by dusting its pathways with racumin powder in wheat crop

6. Five Striped Sqirrel—a serious threat to Pomegranate cultivation in arid areas

7. Off-campus farmers' training on rodent control

8. Field Demonstration on rodent control

ICAR Research Complex For NEH Region, Barapani (Shillong)

1. Survey and Surveillance :

Surveillance of ICAR Research Farm, Barapani, revealed that the rodent activity was highest in the month of August (72.90%) followed by July (67.23%) and least activity was recorded in the month of January (25.35%). The rodent activity was highest in pineapple and paddy fields. The active burrows of rodents in 8 watersheds of FSRP were recorded round the year. It was found that the highest activity of rodents was in the month of August and September and remained upto November. The highest number of active burrows were found in W5 (Crop - maize, pineapple, cowpea and guava) followed by W6 and W4. The least active burrows were found in W7 and W8 (forest area) followed by W1 (fodder crops).

The survey of terraces at nine locations was conducated in ICAR Farm, Barapani. These terraces had different cereal, vegetable, fruit and oilseed crops. The highest activity was found in the month of August in terraces having paddy and pineapple crops. The population persisted upto November.

The survey of fallow land revealed maximum active burrows in the month of July (52.7%) and lowest in the month of January (30.0%) while pine-forest had very low intensity of rodents.

2. Rodent management in terraced cultivation :

a) *Trapping* : Trapping with bandicoot, sherman and snap traps was done to capture the rodents from terraces which proved unsuccessful as very few rats were caught.

b) *Chemical control* : Chemical control of rodents was taken up in 4 terraces each in 4 water sheds of FSRP with bromadiolone wax blocks, zinc phosphide 2% (wheat flour balls) and zinc phosphide 2% (in rice grains). It was found that zinc phosphide 2% in rice grains resulted in the highest reduction of active burrows (94.45%) followed by zinc phosphide 2% wheat flour balls (83.36%) and bromadiolone wax blocks (63.5%).

3. Collection of rodents :

A total of 316 rodents were collected with the help of traps and chemicals from fields, houses and field godowns of ICAR Farm. The bandicoot trap was highly

effective in field godowns (trapability - 70.25%) to sherman trap (trapability 44.21%) but these traps were found ineffective in the fields. 81.45% of total collection was of *Bandicota bengalensis* showing its dominance at the Research farms Situated at Barapani.

4. Damage Assessment in Paddy, Pineapple and Cabbage :

a) *Upland paddy* : The survey of upland paddy revealed maximum active burrows in the month of September when the crop was in grain formation stage. The rodent activity was in tune from August to October which suddenly reduced in November last after harvest of paddy. The average damage by rodents to plants was recorded 11.68% and to tillers 8.65%.

The management of rodents was done with bromadiolone wax blocks, zinc phosphide 2% wheat flour balls and zinc phospide 2% rice grain bait which resulted in the reduction of rodent population by 63.5, 88.5 and 91.3%, respectively.

b) *Lowland paddy* : The survey of lowland paddy at Research Farm revealed maximum activity of rodents in the month of September. It was also noted that early maturing varieties had higher damage. The mean damage in lowland paddy was 12.89% to plant and 8.63% to the tillers. The management of rodents was done through trapping and chemical control. Trapping of rodents with snap traps proved least successful. Zinc phosphide 2% in rice grains reduced maximum number of active burrows (89.93%) followed by zinc phosphide 2% in wheat flour balls (92.25%) and bromadiolone cakes (58.50%).

c) *Pineapple* : The damage to pineapple fruits due to rodents was 8.55%. Maximum damage was found in fully matured fruits during the months of August, September and October.

d) *Cabbage* : The cabbage crop was found damaged by rodents to the extent of 7.81%. The whole cabbage plant was some times found eaten by rats.

e) *Maize* : Maize cobs were found damaged to the extent of 4.6 to 10.33%.

5. Laboratory evaluation of rodenticides :

Bandicota bengalensis were fed with Cholecalciferol for 3 days in 'No Choice Test' resulting into 100% mortality in 3-7 days. In 'Choice Test' with Zinc phosphide 2% kneaded balls, bromadiolone cake, Cholecalciferol cake and plain maize were provided. It was found that plain maize and zinc phosphide 2% kneaded balls were preferred more resulting in 90% mortality of test rodents.

Ready-to-use tracking powder, racumin was tested against *Bandicota bengalensis*. A thin layer of the powder was applied in the middle of the closed box. When the

rats came in contact of the scattered powder they ingested the ave ingredient of racumin while licking their fur. As a result all the test animals ied within 3-8 days.

6. Social Engineering activity on Rodent Control :

A total of 53 houses, 8 shops, 10 laboratories, 12 field gowns and sheds were made rat free during the year. The survey of rodent conducted in ICAR adopted villages and others, revealed that the farmers were ry adament to use rodenticides due to their pets but they preferred the use of traonly.

Indian Institute of Sugarcane Research, Lucknow

1. Efficacy of manual throw of bromadiolone cakes for rodent control in sugarcane :

This study was conducted at the IISR farm. Eight commerical sugarcane fields (1 ha each) were selected having four for the application of rodenticide and remaining four for serving as control. Bromadiolone cakes (app. 10 gm. each) were manually thrown inside each of the four fields at the crop maturity @ 1 kg/ha in such a manner that one cake fell approximately to an area of 10 M x 10 M in a grid pattern. This rodenticidal baiting was repeated after 15 days. Thereafter, assessment of damage was made by examination of 600 canes comprised of 20 canes at 30 spots in a field, at random: Data on the damage to sugarcane by the rats are presented in table 1. It can be clearly seen that cumulative damage is almost same in treated and control fields but fresh damage is much less in the treated field as compared to the control ones. This indicates the effectiveness of the rodenticidal baiting for rat control in sugarcane.

Table 1. Efficacy of manual throw of bromadiolone for rat control in sugarcane.

Fields	Total Damage (%)		Fresh Damage (No. in Damaged cane/ha	
	Treated	Control	Treated	Control
1	3.33	7.91	3	56
2	16.66	2.83	4	52
3	4.00	13.00	20	140
4	8.83	10.00	78	47

2. Determination of appropriate size of row segments for rodent infestation in sugarcane

After validating the criterion of percentage of rat infested row segments for assessment of infestation in this crop this work was taken up. Ten commercial cane fields were selected at the IISR farm for this study. Five cane row segments over their lengths of 5 m, 10 m and each including four in the corners and one in the centre, at random were demarkated by paces and scored for infestation (only presence/absence of burrowing). Therefore, percentage of each type of segments having rat infestation was computed and tested for significance besides comparing on the basis of standard error. These data (table 2) clearly showed that standard error followed rather an inconsistent trend with increase in size of sampling unit and the means of the three units did not differ significantly. This indicates that any of the units can be used.

Table 2. Rodent infested row segements of different sizes for assesement of infestation in sugarcane

Fields	Infestation in row segements (%)		
	5 m	10 m	15 m
1	100	60	20
2	60	40	60
3	80	80	60
4	60	40	100
5	80	60	20
6	100	100	80
7	60	60	80
8	20	80	80
9	40	80	100
10	40	60	60
Mean	NS	NS	NS
	64.0	66.0	66.0
Standard Error	7.90	5.69	8.51

3. Association of rodent damage with insect pest infestation in sugarcane

This study was taken up to see as to how rat damaged cane are inted by insect pests. For this purpose 100 rat damaged canes were collected from ch of 5 fields at random at the Institute farm and examined for insect damage a wilt. The data, presented in table. 3 clearly showed that majority of rat damage canes (67.3%) were infested by borers and wilt (in some cases only) and the rest nained uninfested. This showed that insect infested canes even are not voided by rats.

Table 3. Association of rodent damage with major pests of sugarcane

Type of rat damaged canes	Occurrence (%)
Damage by borers	62.4
Infected by wilt	2.2
Damaged by borers and wilt	3.0
Rat damaged alone	32.4

4. Squirrel damage in sugarcane :

Plant crop of 10 released varieties of sugarcane and 10 LG varies were grown in microplot conditions. Damage to these varieties by squirrels wassessed on whole p'ot basis. Damage was less, in general, this year than last. The idence of damage ranged from the minimum of 13.75% in CoLK 8102 to the mimum of 100% in CoLK 7810. Among the LG varieties also it ranged upto 1% in four varieties viz. 9211, 9212, 9203, 9226 from the minimum of 13.33% n var, 9106.

A.P. Agricultural University, Maruteru

1. Species composition : Two Rodent species, *Bandicota bengalensis* and *Mus booduga* are associated with irrigated rice crop in Andhra Pradesh. Out of there two, the former is the most predominant and serious pest of rice and other field crops.

2. Reproductive biology : In *B. bengalensis*, breeding is common through out the year and percent pregnancy in the field population ranged from 1.77 to 56.25 during July and October, respectively. (Table 1). Maximum breeding activity was noticed at the time of grain hardening or harvesting of the crop in both the seasons (*kharif* 56.25 and *rabi* 12.12).

3. Rodent damage in black gram : Out of 4.90 lakh ha area under black gram cultivation in Andhra Pradesh, half of the area (2.15 lakh ha) is in Guntur District, where damage estimations were carried for 4 years (1991 to 1994). The loss estimations were made based on hoarded pods. The average grain yield loss due to *B. bengalensis* in black gram was estimated as 0.570 kg/burrows or 31.41 kg/ha.

Table 1. Sex ratio and percent pregnanacy of *B. bengalensis*.

Month	No. of animals tested	% Composition		Sex ratio		% Pregnancy
		Male	Female	Male	Female	
June '93	243	47.09	52.11	1.00	1.09	2.70
July '93	2507	47.33	52.67	1.00	1.11	1.77
Aug. '93	1366	44.81	55.19	1.00	1.23	7.72
Sept. '93	418	44.38	55.62	1.00	1.25	13.13
Oct. '93	97	45.43	54.55	1.00	1.20	56.25
Nov. '93	95	44.12	55.88	1.00	1.27	26.32
Dec. '93	184	59.24	40.76	1.00	0.69	10.75
Jan. '94	158	62.66	37.34	1.00	0.60	8.47
Feb. '94	92	52.17	47.83	1.00	0.92	8.52
Mar. '94	67	50.75	49.25	1.00	0.97	12.12
April '94	44	50.00	50.00	1.00	1.00	9.09
Mean	484.64	49.89	50.11	1.00	1.03	14.26

4. Rodent Management : Bromadiolone concentrate (0.25%) was found effective in controlling *B. bengalensis* in irrigated rice when applied at 0.005% concentration bait twice at an interval of 15 days. The control success was 82.37% and 89.74% after first and second baitings, respectively. The cumulative success of two baitings of bromodiolone was 98.17%.

For the control of rodents, particularly in irrigated rice, a mall, compact unit called "Burrow Fumigator" was designed and developed byhe scientists of All India coordinated Research Project on Rodent control at Marutru (Fig. 1). By burning paddy straw, smoke is liberated and is pushed in to the burrow tunnels with the help of blower. Within 10-15 minutes, all the tunnels othe burrow are filled with the smoke and the animals living in side die of suffocatio.

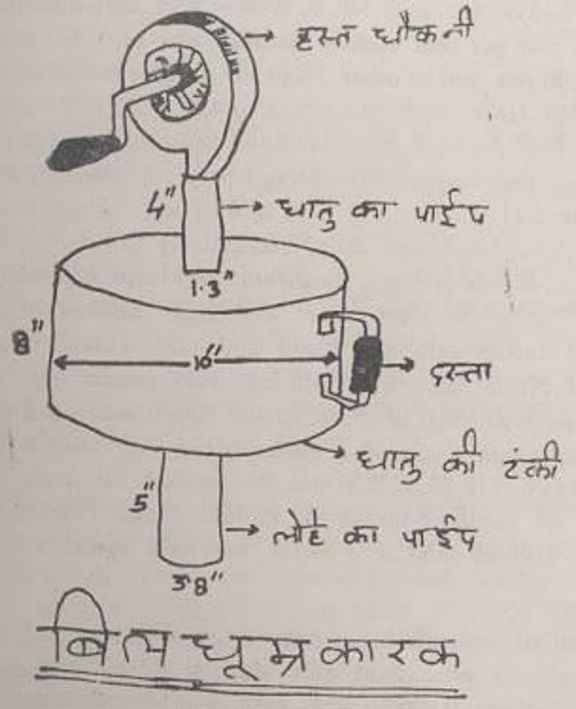


Fig. 1. Burrow funigator

In Godavari Delta, nut damage in coconut gardens is caused b one Rodent species namely *Rattus rattus wroughtoni*. The damage by this rocnt is ranging from 8-21% with an average of 10%. The nut damage can be checkd completely with two crown baitings of bromadiolone concentrate (0.25%) at montly intervals. Two poision baitings with bromadiolone reduces nut infestations t 100% and also delay reinfestation for more than 6 months.

Gujarat Agricultural University, Junagadh

1. **Survey, identification and monitoring of rodent pests in different agroclimatic zones of Gujarat** : The field survey was carried out in different *talukas* of South Saurashtra, North Saurashtra and North West - arid agroclimatic zones. During the survey 3.57 to 5.48 per cent rodent damage was recorded in groundnut, where as it was 1.91 to 7.00 per cent in other crops in summer season of 1993. The rodent damage was recorded from 5.02 to 6.87, 3.88 to 4.32, 3.27 to 3.43, 5.28, 4.27 to 6.08, 5.72 to 6.60 and 3.97 per cent in groundnut, *bajra jowar* green gram, black gram, bean and sugarcane crop, respectively during *kharif*-92, however, it was 1.85 to 6.79, 2.90 to 4.94. 4.42 to 5.13. 2.35 to 3.40, 1.91 to 4.64 and 4.41 per cent in wheat, gram, sugarcane, cotton, chilly and bean crop, respectively during *rabi* 1993-94. Among the different species of field rodents, *Bandicota bengalensis kok* was found predominant (47.80 to 87.80 % (in seven, two and eight *talukas* of South Saurashtra agroclimatic zone during summer, *kharif* and *rabi* season, respectively, and in eleven *talukas* of North Saurashtra during *rabi* season and it was followed by *Millardia meltada meltada* (0.00 to 37.56 %) and *Tatera indica indica* (0.00 to 23.91% However, the predominant species *B. bengalensis kok* (61.07 to 81.25 %) was followed by *T. indica indica* (14.34 to 33.83 %) and *M. meltada meltada* (1.12 to 10.82% in Una. *talukas* of South Saurashtra, Paddhari and Chotila *talukas* of North Saurashtra and in Halvad *talukas* of North west-arid agroclimatic zone during *rabi* season.

2. **Evaluation of rodenticides** : Among four different rodenticides evaluated against field rodents in groundnut crop during *kharif* and wheat crop during *rabi* season, bromadiolone 0.005% wax cake was found superior as it registered the lowest crop damage at various plant growth stages and minimum number of live burrows at 5,7 and 9 days after baiting in both the applications, however, the minimnm number of live burrows at 3 days treatment in both the applications were recorded in zinc phosphide 2 % poison bait. Bromadiolone 0.005% wax cake also gave significantly the highest rodent control success in groundnut (98.48 %) and wheat (87.59%) crops followed by cholecalciferol (0.075 %) and flocumafen (0.005 %). Further, significantly highest yield of groundnut (835 kg/ha) and wheat (4155 kg/ha) was obtained in bromadiolone 0.005% wax cake and it was followed by cholecaliferol 0.075% and flocumafen 0.005% wax blocks.

3. **Population dynamics of major rodents associated with groundnut** : Three species of field rodents viz., *B. bengalensis kok*, *M. meltada meltada* and *T. indica indica* were found damaging the groundnut crop in both summer and *kharif* seasons

Rodent activity was increased from pod formation stage in both the seasons. The population of different rodent species varied from 1 to 23 rodents/100 traps/day during summer and 9 to 31 rodents/100 traps/day during *kharif* season, being the highest at the time of harvest in both the season. In all the three species the male was found predominant with the over all over all male ; female ratio of 61.83 : 38.17 in summer season and 58.39 : 41.61 in during *kharif* season.

4. **Reproductive biology** : Tne reproductive biology of *R. rattus* was studied. The males remain fecunel (53.65 to 83.33%) from April to August-93, December 93 and March-94, however, 45.00 to 60.87 per cent females were in resproductive during April, July, August, November and December-93 and March 94. The active reproductive period was seen during April and June to August (50.00 to 80.00%, December-93 (54.55%) and March-94 (77.77%) Similarly, 8 to 11 embryo/female were also observed during these periods.

5. **Assessment of rodent damage** : The plant damage from 3.46 to 5.39 per cent and pod damage from 4.73 to 5.68 per cent due to rodents were recorded at various crop growth stages in groundnut, whereas 2.67 to 3.23 per cent plant and 3.77 to 4.19 per cent earhead damage was recorded in *bajra* crop during *kharif* season. Similarly, 2.47 to 6.25 per cent and 2.47 to 5.47 per cent rodent damage were recorded at different stages of crop growth in wheat and gram crop, respectively during *rabi* season.

6. **Social engineering activity of rodent control** . Training with demonstrations and mass control campaign under expert supervisions had great impact on reduction of rodent activity as well as plant and pod/earhead damage in groundnut and wheat crops. In maintenance area, significantly lowest plant (0.74 to 1.07%) and pod damage (0.66 to 0.82%) at different crop growth stages and higher yield of groundnut (865 kg/ha) were recorded in *kharif* season. Similarly, significantly lowest plant damage at tillering stage (0.99%) and earhead damage at milky and preharvest stages (0.69 to 0.74%) and higher yield (3770 kg/ha) of wheat crop during *rabi* season were also recorded in maintenance area, however, it was followed by neglected area in both the crops. Looking to the reduction in rodent activity, was recorded at flowering and pod maturity stage, in groundnut respectively, however, it was reduced up to 80.02 and 86.46 per cent at tillering and milky stages of wheat crop, respectively in maintenance area. The rodent activities and plant as well as pod/earhead damages were increased during *kharif* and *rabi* seasons in survey area.

7. **Development of rodent management techniques in groundnut, wheat and cucumbers** : All the three treatments of two existing rodenticides were found effective in reduction of plant damage at germination stage in groundnut, at 30 days after