RECENT ADVANCES IN CO-ORDINATED RESEARCH ON RODENT CONTROL

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AND

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FOREWORD

Rodents inflict incalculable losses to standing crops, harvested crops in threshing floors and to the stored foodgrains and other commodities. Their damaging propensities in rangelands, afforested lands, fruit orchards, plantation crops and poultry farms are also well known. They pose a serious public health hazards by spreading several diseases to man and his pets. During recent years, rodents are also being considered as a serious menace to several non-farm sectors like telecommunication, aviations, railways, etc.

In India, systematic research on rodent management at national level was initiated by the Indian Council of Agricultural Research with the launching of All India Coordinated Research Project on Rodent Control in 1977. In the last more than 20 years, the Project scientists, in ten cooperating centres in different agroclimatic zones of the country, have strived hard and generated useful infrormation on applied rodentology. Technologies evolved under this Coordinated Project are greatly helping the real clientele, the farmers, in containing rodent mance.

With the background of excellent record, in regularly publishing Technology bulletins, Reports and the quarterly Rodent Newsletter, the present publication synthesize the recent initiatives under the Project. I am sure that this compilation would prove quite useful to the students, researchers, policy planners and development officials alike. I appreciate the sincere efforts of Dr. B.D. Rana, Project Coordinator and his team for this exercise.

(R.S. PARODA)

PREFACE

The All India Coordinated Research Project on Rodent Control of the ICAR had its inception in 1977, with four cooperating centres (CAZRI, Jodhpur; UAS, Bangalore; CPCRI, Kasaragod and PAU, Ludhiana). Four more centres (JNKVV, Jabalpur; Acharya N.G.Ranga Agril. Univ.(formerly APAU), Maruteru; IISR, Lucknow (Sardarnagar) and ICAR Research Complex for NEH Region, Barapani(Shillong) were added during the VI Plan period and 2 centres (GAU Junagadh and Dr. YSPU H&F Solan) came into being during the VII Plan. The Coordinating Cell of the Project has been located at CAZRI Jodhpur since the initiation of the Project. Out of ten cooperating centres, 6 are, thus, located in State Agricultural Universities and 4 in ICAR Institutes.

The Project workers have, over the years, made endeavours not only to generate and document new information on different aspects of biology, ecology and behaviour of all important species of rodent pests of crop fields, godowns, orchards, forest plantations, grasslands, etc. but have also made persistent efforts to control the menace by formulating suitable location-specific packages of practices. Periodical publication of the bulletin - RODENT NEWSLETTER - by Coordinating Cell has provided a convenient medium for rodent workers round the country to disseminate interesting, new observations and research results for peer enlightenment. Effective interaction among rodent researchers has also been achieved through biennial workshops/Group Meetings organised under the auspices of the Coordinating Cell at different centres. The Tenth Workshop/Group Meeting, is to be held at Central Arid Zone Research Institute, Jodhpur in October 1999.

The Project workers have not lagged behind in lending their full support to the overall ICAR effort for augmenting food production in the country through pest management, among other measures. One of the strong components of the Project has been its Social Engineering Programme - involving farmers in their fields. In recent times, as the country makes giant strides in different technological fields, nature of the rodent problem has been getting complicated. The Project workers are now frequently called upon by the Departments of Railways, Civil Aviation, Telecommunication and others to help rid their establishments and installations of the rodents.

I feel greatly previleged in expressing my sincerest thanks to the Director General, Dy. Director General (crop Sciences) and ADG (P.P.) ICAR and Director, CAZRI, Jodhpur for extending all possible help and encouragement in execution of the Project and for sincere guidence in publication of this Report. Help rendered by Dr. Mohd. Idris and Vipin Chaudhary, the Technical Officers of P.C. Cell, CAZRI, Jodhpur in compilation of this Report is thankfully acknowledged. Shri Harish Kumar and Shri P.S. Yadav, deserve special thanks for their efficient secretarial assistance.

(B. D. Rana)
Project Coordinator
AICRP on Rodent Control

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AN OUTLINE

Project

Rodents being a serious competitor of mankind cause immense losses at every stage of crop production i.e. from sowing to harvest in the fields and in threshing yards and storage as well. They also transmit several deadly diseases to human being and its pets. Looking into the seriousness of the problem of rodents in agriculture, the Indian Council of Agricultural Research initiated an All India Coordinated Research Project on Rodent Control during October 1977. Initially it was started at 4 centres in the country with Central Arid Zone Research Institute, Jodhpur, as the Coordinating Unit. Besides CAZRI, Jodhpur, the other centres were (i) Punjab Agricultural University, Ludhiana, University of Agricultural Sciences, Bangalore, and (iii) Central Plantation Crops Research Institute, Kasaragod. Considering the diversity in rodent species and cropping pattern in the country 6 more centres were added later on. These are : Indian Institute of Sugarcane Research, Lucknow, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, ICAR Research Complex for NEH Region, Barapani Shillong, A.P. Agricultural University, Hyderabad (during VI Five Year Plan) and Gujarat Agricultural University, Junagadh and Dr. Y.S. Parmar University of Horticulture and Forestry, Solan (during VII Five Year Plan).

Mandates

Following are the important mandates and objectives of the AICRP on Rodent Control :

- The conduct basic and strategic research on rodent population, biology, ecology and crop loss assessments under diffrent agro ecosystems of the country.
- The evaluate multiocational rodent management techniques against major rodent pest to evolve Integrated Pest Management (IPM) systme for different cropping systems.
- To coordinate various research programmes related to rodent management at various cooperating centres.
- To study impact assessment and refinement to rodent management technologies at farmers field under social engineering activity through Krishi Vigyan Kendras.
- Dissemination of information on research accomplishment and creation of trained manpower through practical trainings at various levels for human resource development in the field of rodent control.

The Set Up : The Project is headed by the Project Coordinator stationed at Central Arid Zone Research Institute, Jodhpur. It has ten Cooperating Centres spread in different agroclimatic zones of the country. Of them four centres are located in ICAR

Institutes and the other six are in State Agricultural Universities. The name of the centres and their year of commencement is presented below.

Organisational set up of AICRP on Rodent Control

Centre	Located at	ICAR/SAU	Year of start
Jodhpur (Raj.)	Central Arid Zone Research Institute, Jodhpur.	ICAR	1977
Ludhiana (Punjab)	Dept. of Zoology, Punjab Agricultural University, Ludhiana	SAU	1977
Kasaragod (Kerala)	Central Plantation Crops Research Instt. Kasargod	ICAR	1977
Bangalore (Karnataka)	Dept. of Entomology, University of Agril. Sciences, Bangalore	SAU	1977
Barapani (Meghalaya)	Div. of Entomology, ICAR Research Complex for NEH Region, Barapani	ICAR	1982
Lucknow (UP)	Indian Institute of Sugarcane Research, Lucknow	ICAR	1983
Jabalpur (MP)	Dept. of Entomology, JN Krishi Vishwavidyalaya, Jabalpur.	SAU	1983
Maruteru (A.P.)	Agril. Research Station (ANGRAU), Maruteru (West Godavari)	SAU	1986
Solan (H.P.)	Dept. of Entomology, Dr. YSP Univ. of Hort. & Forestry, Nauni, Solan	SAU	1987
Junagadh (Gujarat)	Dept. of Entomology, College of Agriculture, Gujarat Agril. University, Junagadh	SAU	1987

I. AREAS OF RESEARCH AND PROGRAMMES

Besides multilocational research studies each centre has been entrusted with specific areas of research in respect of crops or commodities on which greater emphasis is to be laid for evolving ecologically sound, economically viable and sociologically acceptable rodent management technologies.

Specific areas of research at various centres

Name of the Centre	Crops/commodities dealt with
Central Arid Zone Research Institute, Jodhpur	Arid zone food crops, horticultural crops, grasses and tree plantations.
Punjab Agricultural University, Ludhiana	Irrigated cropping systems
University of Agricultural Sciences, Bangalore	Dryland crops, Cardamom etc.
ICAR Research Complex for NEH Region, Barapani (Shillong)	NEH crops (paddy, maize, pineapple)
J.N. Krishi Vishva Vidhyalaya, Jabalpur	Pulses crops (gram and soybean)
Acharya N.G.Ranga Agricultural University, Maruteru (West Godavari district)	Wetland paddy
Indian Institute of Sugarcane Research, Lucknow (Sardarnagar, Gorakhpur)	Sugarcane-wheat-mustard
Gujarat Agricultural University, Junagadh	Groundnut
Dr. Y.S. Parmar University of Hort. and Forestry, Nauni (Solan)	Horticultural crops

Group meetings/Workshops : Organisation of the group meetings/workshops is one of the major objectives of the Project to assess the achievements, workout the recommendations of rodent management and to finalise the future research programmes after thorough discussion among various rodent scientists drawn from the coordinated Project and self funded centres. During nineties three group meetings/workshops have been organised and fourth one is to be scheduled in October 6-7, 1999 at Central Arid Zone Research. Institute, Jodhpur.

1. Central Arid Zone Research Institute, Jodhpur (November 13-14, 1991).
2. Gujarat Agricultural University, Junagadh (December 29-31, 1994).
3. University of Agricultural Sciences, Bangalore (January 9-11, 1997).

National Symposium : A two day National Symposium on Rodent Pest Management *-A Scenario for the 21st Century* was organised at CAZRI, Jodhpur during November 15-16, 1991.

Following are the major research programmes of various cooprating centres of the Project :

Central Arid Zone Research Institute, Jodhpur

- Survey, identification and monitoring of Rodents in different agroclimatic zones of Rajasthan.
- Evaluation of relative bioefficacy of existing and newer rodenticides and effect of intermittent control operations on mixed population of rodents in arid zone.
- Assessment of the extent of rodent damage and its distribution in major crops.
- Development of effective rodent control strategies for arid agriculture, horticulture, rangelands and afforestation vis-a vis sand dune stablization sites.
- Ecological takeover of rodents population in relation to changing land use pattern in arid areas.
- Basic behavioural pattern on field application of exudates/excretions/secretions in rodent management.
- Studies on persistence of bait shyness in fields conditions.
- Social engineering activity on rodent control.

2. Punjab Agricultural University, Ludhiana

Survey, monitoring and identification of major rodent pests of Punjab.

- Evaluation of acceptability and bio-efficacy of existing and newer rodenticides.
- Assessment of the extent of the rodent damage and its distribution in crops.
- Relationship between microhabitats and distribution and abundance of rodents in two selected agroclimatic zones.
- Studies on prey-predator relationship, breeding biology and reproductive control of rodents.
- Strategies of rodent control in different crops and orchards and determination of economic injury level in various crops.
- Evaluation of attractants and repellents against various species of rodents.

- Studies on reinfestation rates with various rodenticidal treatments.
- Social engineering activity on Rodent Control. 3. University of Agricultural Sciences, Bangalore
- Survey, monitoring and identification of major rodent pests.
- Evaluation of acceptability and bio-efficacy of existing and newer rodenticides.
- Assessment of the extent of the rodents damage and its distribution in crops.
- Impact of rodent management during lean period and in barren lands and rodent management in cardamom.
- Development of methodology for grading rodents damage in coconut, cocoa and aeronaut plantation.
- Social engineering activity on Rodent Control.
- Behavioural ecology and breeding biology of rodents.
- Bait shyness studies under fields conditions.
- Evaluation of efficacy of chemosrerilants with special reference to products of plant origin.

4. ICAR Research Complex for NEH Region, Barapani

- Survey, identification and monitoring of rodents in different agroclimatic zones in Meghalaya.
- Ecology of rodents in different agroclimatic zones in North-eastern Hill Region.
- Evaluation of acceptability and bio-efficacy of existing and newer rodenticides.
- Bio- ecology of predominant rodent pests and assessment of the extent of damage in major crops of NEH, Region.
- Standardisation of rodent management technology specially for Jhum cultivation, terrace cultivation, bamboo forests and residential premises.
- Studies on reproductive biology of predominant rodent species.
- Social engineering activity on rodent control.

5. J.N. Krishi Vishva Vidhyalaya, Jabalpur

- Survey, identification and monitoring of major rodents pests in Madhya Pradesh.
- Identification and monitoring of rodents and their natural enemies in different agro-climatic zones and assessment of the extent of rodent damage in major crops, and development of integrated management technology for rodents in soybean, gram, wheat, and sorghum.
- Evaluation of acceptability and bioefficacy of existing and newer rodenticides including different bait formulation.

- Studies in management of rodents on poultry farms.
- Studies of rodent fauna in forest areas specially in tribal belts and to estimate the extent of damage to the forest plants/products.
- Social engineering activity on rodent control.

6. Indian Institute of Sugarcane Research, Lucknow

- Survey, identification and monitoring of rodents in different agroclimatic zones of Uttar Pradesh.
- Demographical changes in *Bandicota bengalensis* in different cropping systems.
- Estimation of losses due to rodents to different crops in sugarcane cropping systems.
- Development of viable rodent management technology for sugarcane, wheat and paddy cropping systems in U.P.
- Transfer of rodent control technology through social engineering activity.
- Studies on reproductive biology of predominant rodent species.

7. Agricultural Research Station, Acharya NG Ranga Agril. University, Maruteru

- Survey, identification and monitoring of rodents in different agro-climatic zones of the state.
- Standardization of baiting techniques in irrigated paddy, sugarcane and rice-fallow/ pulses.
- Evaluation of palatability and relative bio-efficacy of existing and newer rodenticides under field conditions and to educate and involve the farmers to adopt viable rodent control strategies.
- Assessment of the extent of rodent damage and its distribution in prevailed cropping system.
- Studies on the reproductive biology of predominant and economically important rodent species.

8. Gujarat Agricultural University, Junagadh

- Survey, identification and monitoring of rodents in different agro climatic zones of the state.
- Damage assessment and identification of losses to dominant crops and field efficacy of existing and newer rodenticides.
- Studies on the reproductive biology and behaviour of predominant rodent species.
- Rodent management in barren land/wasteland and its impact on rodent infestation

in crop land, management of rodent in poultry farms and impact of rodent management during lean period.

- Development of viable rodent management techniques for groundnut, wheat and gram cropping system.
- Population turnover of rodents in relation to changing cropping patterns.
- Evaluation of cost effectiveness of viable management technologies and social engineering activity on rodents in farmers' fields.

9. Dr. YS Parmar University of Hort. & Forestry, Nauni (Solan)

- Survey, identification and monitoring of rodents in different agro climatic zones.
- Evaluation of acceptability and bio efficacy of existing and newer rodenticides.
- Studies on assessment of the extent of rodent damage and its distribution in different crops.
- Studies on the reproductive and population cycles of predominant rodent species.
- Social engineering activity and extension work in rodent control at farmers' field.
- Studies on burrowing behaviour *vis-a-vis* soil strata, irrigation and other environmental factors and homerange activity of rodents.
- Development of rodent management techniques with emphasis on integrated pest management and on evolving safe rodenticidal chemicals which impair fertility at sublethal concentrations.

II. PROGRESS OF RESEARCH

CENTRAL ARID ZONE RESEARCH INSTITUTE, JODHPUR

I. Rodent species composition, population dynamics and extent of damage:

(i) Rainfed crops : Gerbils, *Meriones hurrianae, Gerbillus gleadowi* and *Tatera indica* formed the major rodent pest complex in rainfed crops. *M. hurrianae* and *T. indica* were found to damage the crops in all fields, whereas, *G. gleadowi* was predominant in fields near sand dunes/hummocks only. Field with a burrow density of 5/m^2 experienced complete loss of plant stand at early stage of crop growth, whereas, those with 1-2 burrow/m^2 caused 37.5-68.0% loss in plant stand. As a solo crop moth/ moong experienced higher damage (56.6 and 61.0%) in comparison to mixed crop of bajra + moth (38.3%). Second peak in damage is noticed at the maturity of the crop and after harvest in the threshing yards.

(ii) Irrigated crops : Mustard fields harboured 23-48.0 (Av. 35.5) live burrows/ha during seedling stage resulting in 30.0% loss in the plant stand. Similarly gram and pea experienced 19.6 and 18.75% reduction in plant stand due to rodent pest attack. Rodent pest complex of *M. hurrianae - T. indica* and *G. gleadowi* inhabiting gram fields caused significant reduction in plant population at vegetative growth stage. The pest population showed a burrow density of 17.0 (*M. hurrianae*) and 10.1 (*T. indica*) on bunds (per 10 m length).

(iii) Grasslands and silviculture : Population fluctuation in perennial cropping systems revealed predominance of *T. indica* followed by *M. hurrianae* at CAZRI Farm. The population was lowest during summers and highest during post monsoon (September). Overall burrow counts (3 year mean) varied from 77.3 - 97.3/ha in silva fields and 82.0-105 in grassland. Rodent population was lowest during 1995-96 in comparison to 1993-94. Trap index varied from 2.8-3.3 rodents per 100 traps per day.

(iv) Horticulture : In ber and pomegranate orchards infestation of *T. indica, Funambulus pennanti, Millardia meltada* and *M. hurrianae* was reported. Of these F. pennanti was a major problem in pomegranate. Rodent damage to ber nursery revealed 8.0-80.0% damage in the wiremesh covered beds due to Indian gerbil and squirrels, whereas, uncovered beds recorded cent percent damage. At CRF, datepalm and pomegranate orchards recorded predominance of *T. indica* (66.6 and 61.2% respectively). Three year mean data on squirrel and bird damage to various cultivars of pomegranate revealed that the varieties having higher fruit juice, soft seeds viz., khog, Jalore seedless and G-137 were comparatively less preferred by these pests (6.1

- 11.3% fruit damage). On the other hand Bassein seedless proved most susceptible to squirrels recording 56.6% mean damage.

II. Ecological evaluation in canal command areas : During this study two sites, one in IGNP and other in Jowai canal area were surveyed for rodent pest complex in irrigated crops. In IGNP, survey was conducted at Bajju where irrigated crops like gram, mustard, wheat and groundnut crop were introduced for 5-10 years only. The rodent trapped were mainly of xeric habitat i.e., *G. gleadowi, M. hurrianae* and *T. indica*. No mesic species was reported in this area whereas these have established their population in Sri Ganganagar area which is under canal irrigation since last 60 years. Species composition in Jowai canal command area was entirely different, where population of mesic and submesic species like *Bandicota bengalensis* and *R. meltada* were noticed. The irrigated crops of this area were infested by Golunda ellioti and *T. indica* also. Common house rat, *Rattus rattus* was also trapped from crop fields for the first time during 1995-96.

III. Rodent management : Wax block formulation of zinc phosphide, an acute poison were tried in laboratory against *Meriones hurrianae, Rattus rattus* and *Funambulus pennanti*. One day exposure of this formulation under no choice yielded 60, 40 and 40.0% mortality of *M. hurrianae, R. rattus* and *F. pennanti* respectively. The effectiveness of this formulation was also compared with that of freshly prepared loose bait of zinc phosphide, which yielded 100% mortality of test rodents. An exposure of 0.75% coumatetralyl tracking powder for one hour/day resulted in 50% kill of house mouse, *Mus musculus* in laboratory.

Flocoumafen (0.005%) in freshly prepared bait (bajra + 2% oil + 1% sugar) was evaluated against house rats collected from poultry farms and residential areas. Mortality in single day exposure was 50.0 and 62.5% respectively for both the populations of house rats. Both the populations preferred bajra based poison bait of anticoagulant over poultry feed based poison bait.

Studies on efficacy of wax block baits of zinc phosphide revealed that around 40% of *F. pennanti*, 60% of *R. rattus* and 30% of *M. musculus* survived its one day exposure. The residual rodents developed bait/poison shyness. Exposure of these shy population to bromadiolone and brodifacoum at 0.005% yielded 100% kill of test rodents.

Field evaluation of wax block baits of bromadiolone (0.005%) and zinc phosphide (2.0%) was conducted in and around ber orchards. Control success was 88.8 and 69.3% respectively. Analysis of the feeding patterns of second generation anticoagulant rodenticide - bromadiolone indicated that with the increase in baiting period from 1-4 days in no choice, the daily consumption of the poison bait ranges from 14-30% in *R. rattus*, irrespective of concentration (0.0025, 0.005 and 0.01%) in

pearl millet baits. More than 80.0% of the total poison intake took place in the first three days. Hence, it may be concluded that bromadiolone baiting may not be continued beyond 3 days in a single stretch for effective management of house rats.

Pellet and waxcake formulation of brodifacoum (0.005%) were further screened in various crops viz., groundnut, cotton, pearl millet, moong, moth, chillies, cucurbit and range lands and poultry farms. Both the formulations of brodifacoum viz, wax blocks and pellets recorded 80-92.0% control success within fifteen days of burrow baitings in different crop fields, rangelands and poultry farms. The predominant rodent species in these crops were, *T.indica, M.hurrianae, R.meltada*, and *Mus booduga*. However, poultry farms were inhabited by house rat , *R. rattus* and house mouse, *M. musculus*. Similarly in ber orchards too, this rodenticide yielded 91.5% success. The orchards were infested by arboreal rodent, *Funambulus pennanti* and fossorrial ones like, *T.indica, M.hurrianae,* and *R.meltada* On the basis of these findings, brodifacoum (0.005%) may be recommended for rodent pest management in crop fields and poultry farms.

Preliminary studies on repellent/deterrent effect of jojoba cakes against *T. indica* and *R. rattus* revealed that there was strong aversion for the cakes by both the test rodents. The test rodents preferred to remain hungry. There was a net weight loss of 5.5-10.0 gm in *T. indica* and 6-13.0 gm in *R. rattus* during three days exposure.

Studies on efficacy of a new second generation anticoagulant rodenticides, difethialone (0.0025%) was initiated against house rats and both the gerbils, i.e. *Tatera indica* and Meriones hurrianae. The freshly prepared bajra based bait of the anticoagulant yielded cent per cent mortality of rodents in no choice under laboratory conditions. The poison bait recorded fairly good acceptability by the test rodents. This anticoagulant yielded 100% mortality of gerbils (*T. indica*) at 0.0025% concentration in one day exposure under no choice test. The death period varied from 5.0-9.0 days and mean poison ingestion was 2.0 ± 0.31 mg/kg. Similarly 77.8% merion gerbils were knocked down within 4-11 days recording a consumption of a.i. 1.73 ± 0.22 in laboratory trials. The rodenticide proved superior to other anticoagulants of the same generation, because the desired concentration of a.i. in bait is only 25 ppm whereas others viz., bromadiolone, brodifacoum and flocoumafen are effective at 50 ppm concentration in baits. Field trials with its anticoagulant rodenticides in wheat and groundnut crops too yielded over 80.0% control success with in a fortnight of its applications in live burrows.

Racumin - a tracking powder containing coumatetralyl as active ingredient was tried in plus mazes for its efficacy against house rats. One hour exposure of the thin film of this powder yielded 50.0% mortality of house rats.

IV. Social Engineering Activity On Rodent Control : Under this Project 15-20 farmers were identified in each study areas. Opinion survey revealed that 60 to70% farmers knew about the 'kala powder' (zinc phosphides) but most of them did not know about how much quantity, what type of bait and additives should be used for the preparation of poison bait. How much quantity of poison bait should be inserted into each a active burrow/placement of poison bait. Whether control operation should be done in morning or evening or in the late evening. Secondly, pre baiting should be done or not before each operation and prior to sowing of crops etc. Beside they should know about periodicity of the development of the bait and poison shyness and disposal of the dead rodent after the operation. Such right information was not available with the farmers. So we arranged live demonstration about these aspects.

PUNJAB AGRICULTURAL UNIVERSITY, LUDHIANA

I. Survey and monitoring of rodent pests : In Punjab eleven species of rodents viz., *B. bengalensis, R. meltada, T. indica, Nesokia indica, Golunda ellioti, M. hurrianae, R. rattus, M. musculus, M. booduga, M. platythrix* and *Funambulus pennanti* have been recorded. Districtwise surveys of rodents revealed the predominance of *B. bengalensis* in irrigated fields of Ludhiana, Ropar, Kapurthala and Jalandhar, whereas the unirrigated fields were predominantly inhabited by *T. indica and Mus species.* In the less irrigated sandy soils, R. meltada was the major pest. In the central plains of Ludhiana, Jalandhar, Ropar and Kapurthala districts the species composition in order of predominance was *B. bengalensis , R. meltada, T. indica, Mus species, G. ellioti.* In sandy soils in North-Western districts (Bhatinda, Ferozepur and Faridkot) *T. indica* and *R. meltada* were abundant. In the alkaline soils only R. meltada was recorded.

Crop-wise survey revealed that *B. bengalensis* is most predominant in rice-wheat rotations and in sugarcane and *T. indica* in groundnut, millet, cotton and pulses in Bhatinda region.

Change in cropping system affects the predominance of rodent pests as with increased rice cultivation *B. bengalensis* increased several fold and now it represents 80 to 100% of the total catch. Introduction of new crop in an area also aggravate certain pest problems as in village Upland, which recently adopted to sugarcane cultivation, *T. indica* also turned serious pest of sugarcane along with *B. bengalensis. T. indica* also inflicted damage in the shoot region where as generally rodents cut the lower internodes of sugarcane.

II. Assessment of extent of rodent damage to major crops : Survey of rodent damage was conducted in sixty villages of Punjab to assess the extent of rodent damage to wheat, rice and sugarcane. Rodent damage studies revealed that sugarcane and

paddy crops are the most vulnerable to rodent damage. The rodent damage to cereals are very high in 'bet' areas and in the fields near sugarcane fields which is sometimes as high as 25%. Average damage to rice and wheat in different years ranged between 4 to 6% in wheat and 4 to 10% in sugarcane. In winter maize, they cause 10.7% damage at the seedling stage only. Rodent inflict severe damage to vegetable crops particularly to cucurbits. The maximum rodent damage in cucurbits has been between rind formation and maturity stage i.e. 5.17-18.38% in tomato, 5.26-9.67% in summer squash, 11.11-37.10% long melon, 6.45-15.22 in musk melon.

III. Acceptability and bio-efficacy of rodenticides : Rodenticides including the first generation anticoagulants coumatetralyl and the second generation anticoagulants namely brodifacoum, bromadiolone, flocoumafen and difethialone, and vitamin D3 formulation namely cholecalciferol were evaluated in laboratory and field trials along with acute rodenticide, zinc phosphide. Their dose and method of application, species susceptibility, acceptance and field efficacies against the major rodent pests of Punjab were determined in laboratory as well as in different crop fields i.e. wheat, paddy, groundnut, sugarcane as well as in poultry houses and residential premises. Use of Zinc phosphide (2%), Bromadiolone (0.005%), and Brodifacoum (0.005%) have been recommended for the control of rodent in Punjab. Racumin (0.0375%) bait has been found very effective against major rodent pest and recommendation of its use for rodent control in wheat-rice rotation has been included in the Proceedings of the Group Meeting of AICRP on Rodent Control held at Bangalore, January 1997. Laboratory and field evaluation of a new rodenticide Difethialone started in 1997.

Freshly prepared baits of rodenticides were more accepted by rodents than their ready to use formulations and in field conditions single baiting causes 54.9-74.6% rodent control. For control of rodents in mature wheat and other crops where the congenital baiting technique fail due to abundance of food from the crop, a new poison delivery system involving the dusting of runways and burrows of rodents with racumin dust has been developed. Effective and safe (less hazardous to non-target animals) method of control of house rat has been developed using vitamin D3 as a rodenticide.

New technique for integrated application of rodenticide baits and dust of zinc phosphide has been developed. It involved the use of a specially designed box (Robox) preventing non-target poisoning and it is useful for control of house rats in indoor premises.

IV. Social Engineering Activity of Rodent Control : Social engineering research trials were carried out in twelve villages namely Bhaghpur, Raiyan, Kumbhkalan, Malik,

Cheemna, Bujker, Pitipur, Buddewal, Mehlon, Bukhri, Dhanansu and Aligarh. In these villages farmers were educated and trained for rodent control. Previously the village level collective approach of farmers motivation, education, training and rodent control operation was adopted. In 1994 along with this approach individual farmer approach was also been practiced. For individual farmer approach second generation anticoagulant was introduced. In these village, 42-87% rodent control success was achieved which resulted in increasing production of 161-202 kg/ha of wheat, 164-254 kg/ha of rice and 26-40 q/ha of sugarcane. Acceptance of technology by farmers was also tested and it was found that more than 50% farmers commit mistakes in preparation and application of baits and thus reducing their effectiveness and also enhancing bait shyness.

V. Behavioural ecology of rodents : Different behaviours of rodents including bait-shyness, feeding behaviour in rice crop, relationship of burrowing and feeding in wheat, grooming, below ground feeding in orchards were studied. Extensive trials were conducted to study the bait preference behaviour and responses of rodents towards several natural and artificial chemicals in order to formulate suitable baits for rodent control. Bait acceptance at different crop stages and in different ecological conditions were studied to identify the suitable time of baiting in crop fields.

VI. Resiliency management in rodent populations with genetic and reproductive control : A toxicant-cum-steriant, alpha-chlorohydrin, was evaluated against the Indian mole rat *B. bengalensis* and *R. rattus*. It caused 100% mortality of *B. bengalensis* at 100 mg/kg but no mortality was observed in *R. rattus* even at 300 mg/kg dose. The acute LD 50 for *B. bengalensis* was found to be 82 mg/kg. Studies of the effect of alpha-chlorohydrin on the social and aggressive behaviours of *B. bengalensis* and testing of its efficacy in sugarcane fields showed that this chemical can effectively check post control rebuild up rat which is major problem in rodent control.

A germ cell mutagen namely ethyl methane sulphonate its 100-150 mg/kg b.w. and 500 mg/kg was found to cause dose dependent sperm abnormalities (mainly acrosomelessness) in *B. bengalensis* and *R. rattus* respectively. Potential of this technique in rodent control is being further investigated.

UNIVERSITY OF AGRICULTURAL SCIENCES, BANGALORE

I. Rodent survey : The studies on identifying major pests of eight out of the ten agroclamitic zones were completed. The studies indicated M. metlada, *T. indica*, *R. rattus* and Mus species as the major pest of Central Dry Zone; *B. bengalensis, M. meltada, M. platythrix, T. indica* and *M. booduga* in Eastern and Southern Dry Zone; *B. bengalensis, T. indica, M. meltada and Mus species* in Southern Transition Zone;

B. bengalensis, F. palmarum and M. meltada in Hill zone; *B. bengalensis, R. rattus (wroughtoni), R. rattus rufescens, F. tristriatus, H. indica* as the major pests and *T. indica, M. meltada* as the minor species in the Coastal Zone; *B. bengalensis, M. meltada* and *T. indica* were predominant in North Dry Zone; whereas *M. meltada, B. bengalensis* and *T. indica* infested the crops more than other species in the Northern Transition Zone. In the rural residential premises *R. rattus and B. indica* were the major species in all the eight zones studied.

II. Rodent damage : For cereals, the damage was 6-12.5% to Ragi, 4-7% at germination/seedling stage. Similarly maize recorded 7% during cob formation, 9-10%to rice at milky stage and grain formation, 50-80% to germinating Jowar and 5-10% to wheat at the time of harvest. The damage to oilseeds was 30-40% to germination/ seedling of Groundnut, 4-9% to mature pods, 30-40% to seed sown/seedling of Sunflower and 1-2% at seed formation of Sunflower. Among the pulses, in Redgram 50-100% damage occurred at seeding stage and 2% at pod formation, Soybeen was affected negligibly viz 0.6-0.77% at pod formation stage. Damage of 10% was observed during the vegetative growth of green gram.

Moderate damage of 5% was caused to potato seedling, 5% to potato tubers and 4% to tubers of sweet potato. Negligible damage of 2-2% occurred to Banana. Amongst the plantation crops, damage to coconut was 5-10%, 2-3% to aeronaut and 11% to the cardamom.

III. Rodent management : (a) Quintox (Cholecicferol 0.755) (i) Choice feeding tests : Given choice of cake, pellet/cereal bait : *B. bengalensis* perfered cereal>cake>pellet and *T. indica* preferred cereal> pellet> cake.

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

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

(b) Racumin : All the concentration evaluated (0.05, 0.06, 0.075 ,0.097 and 0.0975) resulted in the 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 concentration to 0.975% the consmpuation of poison bait reduced and duration of death increased. Hence 0.075% was considered optimal concentration of racumin for the control R. meltada and *T. indica.*

(c) Brodifacoum induced 100% mortality of *R. rattus, T. indica, B. bengalensis* and B. indica in the laboratory.

(d) Difethiaolone : (0.025%) in cereal bait was evaluated against several Species of rodents in the laboratory, in several crops and in poultry. The rodenticide induced 100% mortality of *B. bengalensis*, and *T. indica*, *R. rattus*. *M. platythrix*, *M. booduga* and *F. palmarum* in the laboratory. In the fields it killed 70% rodents in Paddy fields, 71% in Ragi, 62-70% in groundnut, 70 % in coconut and 90-95% in poultry. In Cardamom it prevented 56% damage in capsules.

VI. Social Engineering Activity on Rodent Control : Social engineering activity on rodent control was carried out in Five villages namely Hariharapura, Marogndanahalli, Kasaraghatta, Padarahalli and Basavanapalya. Only rainfed cultivation was carried out in these village. The major crops were Paddy, Ragi, Groundnut, Maize, Coconut and Vegetable. In the next phase this activity was carried out in three villages namely Mavallipura, subedarpalya and Maylappanahalli for two years. A socic- economic survey and also on awareness existing prior to control and awareness enhanced after control were carried out. Mostly kharif crop were raised. Major crops were ragi, paddy and maize. To a small extent pulses, groundnut, vegetables were cultivated.

Rodent control reduced pest population by 85-95% during 1995 and 45-65% during 1996. After control *B. bengalensis* replaced *M. meltada* as the major species in two villages in the third village gerbil replaced bandicoots consequent to rodent control. Damage prevented ranged 10-69%. Awareness about rodent pests and their control increased and farmers were willing to continue rodent control operations on their own in future. Subsequently, this project was initiated in three new villages namely Jangamasigehalli, Shravanur and Neralaghatta. Rodent control success was in the range of 70-69%. At a different seasons bandicoots, gerbil and metads were dominant prior to control in Shravanur and Neralaghatta. But after control Mus species become predominant. However, in Jangamasigehalli bandicoots remained dominant before and after control. Percent damage prevented ranged from 58 to 80% and 100% awareness was created about rodent control amongst the farmers.

ICAR RESEARCH COMPLEX FOR NEH REGION, BARAPANI

I. Rodent survey : Fifteen species were recorded from the NEH region belonging to genus *Rattus, Bandicota, Cannomys, Mus, Vendeleuria* and *Collosciurus*. Of these *B. bengalensis* was the predominant (31.57%) followed by the *R. nitidus nitidus* (24.5%). Sex ratio of different species was 1: 0.99 (*R. intidus*); 1:1.33 (*M.booduga*) and 1:1.5 (*Cannomys badius badius*) . At the Barapani farm, 37.4 and 49.0% burrows were found active during 1991-96 period. Average number of burrows per ha varied between 4.39-7.34. Burrows surveillance in different agro-ecosysytem revealed maximum burrows in maize fields (9.0/ha)followed by the low land paddy (7.8/ha) and upland

paddy (6.0/ha). Fruit orchards harboured least pest population (5.5 burrows/ha) during 1995-96. In kolasib, *R. norvegicus* was also trapped during December, 1995.

II. Rodent damage assessments : In Meghalaya rodents caused 12.5 and 9.9 % damage to lowland and upland rice crops, respectively, while in Mizoram it was 4.3% only. The damage is more pronounced at grain forming stage. Maize crop and pine-apple fruits suffered 9.14 and 8.53 % loss in Meghalaya, whereas it was 7.95 and 4.71 respectively in Mizoram. During 1996, rice crop was badly damaged by rodents in Jayantia hills. The peripheral regions of the crop fields bordering forests were completely destroyed by rodents. Mean damage in three village of the area ranged from 0.40-2.84%. *B. bengalensis* was observed to hoard 0.230-5.100 kg of rice per burrow system. This species was observed to damage mushroom cubes by making tunnels. Tree mouse, *V. oleracia* was found to make nests in the honey bee boxes.

III. Rodent behaviour and breeding biology : Burrowing behaviour of *M. booduga* and *B. bengalensis* was studied in detail. Burrow opening of the mouse was 8.5-11.00 cm in circumference, with a burrow length of 80-120 cm with one or two nest chambers. *B. bengalensis* made complicated burrows on bunds in paddy fields. There were 4-14 openings per burrow having ramified arms (upto 18 m long). On an average 2-6 nest/hoarding chambers were noticed in each burrow system. The number of occupants per burrow was 1 male and 1 female. However, litter of 3-9 pups was noticed during October-December. The litter size of *B. bengalensis* bred in laboratory cage and rattery ranged between 2-8 and 7-8 per female respectively. Optimum weaning period of youngones was 20-30 days and their eyes opened on 18th day of birth. Litter size in B. indica was 4-7 per female.

IV. Rodent management : (i) Evaluation of traps : In indoor habitats, glue traps were found most successful followed by bandicoot and sherman traps. It was further observed that when traps are painted black, the trapability increased to the extent of 45%. In another study, sherman traps recorded higher trapability (12.1%) than snap traps (7.0%). Maximum catches were observed during winters i.e. November to January and minimum during August to October.

(ii) Evaluation of rodenticides : The centre evaluated several rodenticides viz., bromadiolone, flocoumafen, coumatetralyl, cholecalciferol and difethialone in laboratory and fields. Saliant findings are:

- Single exposure of bromadiolone wax blocks resulted in 90% mortality of *B. bengalensis* in 6.89 days (range 3-13 days) in no choice, whereas in 2-3 days exposure it was 86.7-93.3% in choice conditions.
- Flocoumafen (0.005%) yielded 95% kill of bandicoots in 3-13 days in no-choice test in one day exposures, whereas it was 90-95 in choice test when the poison was exposed for 2-3 days.

- Cholecalciferol (0.075%) ready to use wax block formulation resulted in 70, 90 and 100% mortality of *B. bengalensis* in one, two and three days exposure under no-choice. The days to death ranged between 3-14, 4-15 and 3-8 days for different treatments respectively.
- Various formulations of coumatetralyl, were evaluated against *Bandicota bengalensis* and *Mus musculus*. The chemical was found to be a potent rodenticide yielding over 90% mortality.
- Single day exposure of difethialone (25 ppm) as loose bait and wax block resulted in 100% mortality of bandicoots in 4-15 days period.
- One treatment of zinc phosphide (2.0%) followed by two baiting of bromadiolone (0.005%) and difethialone (0.0025%) at 15 days interval results in over 72% control success in protecting from cob damage in maize. Similarly 80.48% fruit damage in pineapple could be reduced by single application of bromadiolone (0.005%) wax blocks in bait stations. This anticoagulant was found to be safe and effective for the control of commensal rodents in houses, godowns, shops and poultry farms.

IV. Social Engineering Activity on Rodent Control : This activity was continued in urban locations. More than 200 users were trained in rodent control. Adoption of the rodent management technology was very slow. In rural areas too, farmers were largely dependent on zinc phosphide supplied to them by state government. No farmer adopted prebaiting, hence, the results were not satisfactory. They were demonstrated with the latest rodent management technology. On the other hand farmers of Khasi hills do smoking of burrows and domestications of cats, besides using local traps for rodent control in their farms and houses.

INDIAN INSTITUTE OF SUGARCANE RESEARCH, LUCKNOW

I. Survey and monitoring of rodent pests : The study was carried out in north-eastern plains of Uttar Pradesh, where sugarcane, wheat, mustard and rice constitutes the main cropping pattern. This region consists of Kachar lands, waterlogged areas, Bhat soils (calcareous), Terai, upland crop and low land crop fields. *B. bengalensis* was the predominant species followed by *M. booduga, R. meltada* and *T. indica*. In the Bhat soil areas, *B. bengalensis* was followed by *T. indica*. Overall rodent population was higher in upland and Bhat soils, whereas it was lower in low land areas. In the flood prone areas of Gorakhpur, the species composition was *T. indica* (64.28%), *B. bengalensis* (28.58%), *R. meltada* and *M. booduga* (3.58% each).

II. Population dynamics of rodents in sugarcane : Rodent pest population is lowest during March-April, which gradually increases and reaches to its peak during May-June and November-December and later it declines. Lower population in March-April in sugarcane fields indicated that the rodents migrate to maturing wheat crop.

This aspect is further confirmed by the fact that pest population is higher (25.13) in wheat fields closer to the sugarcane crop than those away from sugarcane (9.40). Similarly level of infestation and per cent damage was also significantly more in such wheat fields with sugarcane crop. Cane density too was found to influence the infestation patterns. Sugarcane fields with very high cane density (14/m^2) harboured 165.14 burrows whereas, it was only 64.4 and 39.0 in low (7 cane/m^2) and medium (10 canes/m^2) cane density field respectively. Rodents were observed to prefer thick canes for damage.

III. Rodent damage : Rodent damage in sugarcane generally assumes significance during maturity stage. Attempts were made to assess the rodent damage before maturity. Assessment on whole field basis indicated that the damage was 8.74 canes/ha at this stage in upland crops. Overall incidence of damage over 4 years upto maturity stage has been 8.3%. Study on crop stage wise rodent damage revealed that during premonsoon period hardly 20% fields showed pest incidence. However, upto December the damage was 2.95%. The damage level upto harvest stage reaches to about 22.3% (on weight basis). Different varieties were also field screened for rodent damage. CoLK 8901 variety experienced maximum damage (13.3%) followed by Co 1148 (10.6), CoS 8436 (5.6%), CoLK 800 (2.6%), whereas variety CoS 767 recorded no rodent damage at all. It was seen in other trials that lodged canes were more damaged than the standing canes. Varietal screening was further continued for squirrel damage. The damage varied from 15.47 (Co 1148) to 63.15% (CoLK 7810) in plant crop and 0.0 (CoLK 8102) to 66.6% (Co 991) in ratoon crop.

IV. Bait preferences : Of the various bait material and additives tested, *B. bengalensis* recorded maximum preference for rice flour + 10% sesame oil + 1% sugar followed by rice flour + 10% sesame oil. Pearlmillet based baits were least preferred by the lesser bandicoot.

V. Rodent management : Zinc phosphide and bromadiolone were evaluated in different combination and varying stages of crop growth in sugarcane and wheat. Among different treatments, broadcast of Zinc phosphide loose bait followed by bromadiolone loose bait yielded 80.6% control success, whereas, broadcasting of Zinc phosphide flour balls followed by bromadiolone loose bait could yield 64.3% control. Bromadiolone baiting singly or twice gave 58-85% success. Burrow baiting with zinc phosphide and bromadiolone was also attempted in wheat fields at preflowering and flowering stages. During 1991 maximum control success was achieved by the treatment of bromadiolone followed by Zinc phosphide whereas in 1992 it was reverse i.e. zinc phosphide baiting followed by bromadiolone baiting. For poison baiting is inaccecible sugarcane fields, use of catapults was suggested for broadcasting of baits, because hand throwing not possible beyond 27 meters. By the use of catapult the bait can be thrown upto 42 meters, hence a field upto 100 m wide can be poison baited by this method.

VI. Social Engineering Activity on Rodent Control : This project was conducted around Sardarnagar and Gorakhpur. After regular control operations in the maintenance area, the rodent damage was reduced to 1.84-4.2% in sugarcane and 0.59-1.14% in wheat. Zinc phosphide baiting (with one day prebaiting) followed by bromadiolone in the fields yielded 77.23-91.25% control success in fields under farm conditions and 89.32-91.5% in farmer field conditions. Similarly in residential premises, bromadiolone baiting resulted in 74.9-81.8% control success in the villages under maintenance area. Overall control success in wheat, sugarcane and paddy, due to social engineering activity was worked out to be 79.4%, 47.17% and 72.42% respectively in maintenance areas in comparison to survey areas.

JAWAHARLAL NEHRU KRISHI VISHWA VIDYALAYA, JABALPUR

I. Rodent survey : The regular surveys conducted on rodents in different agrocliamitic zones, showed the occurrence of M. meltada, *B. bengalensis*, *R. rattus* rufescens, *R. rattus* narbadae, *T. indica*, *M. booduga*, *M. musculus*, *M .m. urbanus*, *R. norvegicus*, *M. saxicola*, *G. ellioti*, *F. pennanti* and *H. indica*. Out of these *M. meltada* and *Bandcota bengalensis* were found to be ubiquitous. The rodents, which invaded poultry farms were *R. rattus rufescens*, *B. bengalensis* and *M. meltada*.

Monitoring of rodents also indicated the regular activity of *M. meltada* and *B. bengalensis* throughout the year. The soft furred rat, *M. meltada* was dominant during kharif, while bandicoot rat, *B. bengalensis* stood second. A upsurge of *M. meltada* was noted during survey in rabi. The proportion of distribution of *M. meltada* and *B. bengalensis* in soybean and gram crop was observed to be 65 and 35% at the peak activity of these species. The composition of rodents in different crops is as follows :

Soybean	*M. meltada*, *B. bengalensis*, *M. booduga*
Rice	*M. meltada*, *B. bengalensis*, *M. booduga*, *Mus musculus*, *F. pennanti*, *G. ellioti*.
Wheat	*M. meltada*, *B. bengalensis*, *M. booduga*, *Mus musculus*, *T. indica*
Sugarcane	*B. bengalensis*, R. *r. rufescens*
Gram	*M. meltada*, *B. bengalensis*
Groundnut	*M. meltada*, *B. bengalensis*, *F. pennanti*.

II. Rodent damage : The work done on the assessment of losses in different crops is as follows :

Crop	Losses in yield (kg/ha)	Damaged plants(%)
Soybean	3.04 to 70	-
Rice	2.00 to 90	-
Wheat	3.00 to 200 & 0.11 to 28.0/kg/threshing floor	-
Gram	0.20 to 33	-
Sugarcane	46.00 to 449	-
Potato	17.07 to 21.32 hoarding losses	-
Groundnut	-	0.00 to 17.22
Opium	-	0.00 to 1.5

The rodent damage in soybean and rice fields was comparatively more in the fields located nearby villages as compared to fields situated away from them.

III. Rodent management : The study on the testing of rodenticides was done under laboratory and fields. Under fields their acceptability was also recorded in some selected trials.

(i) Zinc phosphide @ 1.75, 2.0 and 2.25% and Bromadiolone @ 0.0025, 0.005 and 0.0075%were tested against *R. rattus*. The results showed that zinc phosphide in each concentration caused cent per cent mortality in both the sexes. While bromadiolone with 0.0075% caused cent per cent mortality. The above rodenticide with 0.005% gave 100% mortality in male and 83.33% in female. Bromadiolone 0.0025% caused 50% mortality in male and 66.66% in female.

(ii) In the study on the comparative bioefficacy of bromadiolone 0.005% (wax blocks) and flocoumafen 0.005% (wax blocks) against *R. rattus* it was found that bromadiolone and flocoumafen registered 91.50 and 100% mortality within 11 and 4-16 days, respectively when the rodenticides were used at the dose of 15 g/animal with exposure of 15 hrs. The mean body weight ranged between 103.70 to 113.21 g in the test animals.

(iii) Studies carried out on the comparative efficacy of bromadiolone (0.005%) and flocoumafen (0.005%) wax blocks, indicated their equal effectiveness in burrow reduction in rice field. The cumulative acceptability after 3 days was 90% and 100% with bromadiolone and flocoumafen, respectively.

(iv) Two anticoagulants namely, flocoumafen 0.005% and cholecalciferol 0.075% wax blocks were placed continuously for 3 days. The data recorded after 6 days of application revealed 75.67 and 88.5% control success respectively.

(v) Field trial with (2%) zinc phosphide and bromadiolone 0.005% proved at par in effectiveness in the control of rodents in gram crop. Highest mean damage (38.31 pods/m^2) was recorded in control as compared to zinc phosphide (21-47 pods/m^2) and bromadiolone (25.16 pods/m^2) treated plots. The acceptability was same (62.50%) in both the rodenticidal treatments.

IV. Management of Rodents in Poultry : (i) Studies made visually on the assessment of losses in poultry and it was found that on an average rodents caused annual loss worth Rs. 8744.33.

(ii) Four different food materials were tested for the preference of R. *r. rufescens* in poultry. The results indicated that the wheat flour (pill) was consumed to a greater degree by the rats and was found significant over rest of the food materials. The next preferred food material was water soaked wheat and was significant over parched rice.

(iii) The studies on trap efficacy showed that wonder traps proved significantly better than the glue strap in trapping *R. rattus*. The mean trapped population was 3.11 and 0.77 in wonder and glue trap, respectively.

V. Reproductive biology of *M. meltada* : The mean monthly body weight of the male *M. meltada* varied from 64.5 to 92.72 g. The maximum body weight was found in September. Mean paired testicular weight varied from 1.16 to 2.16 g. The testes was scrotal in position in all the males. In female, mean monthly body weight varied from 35 to 76.52 g during July to November and was found maximum in October. The mean paired ovarian weight varied from 0.018 to 0.513 g. Pregnant females were observed only in September and October. The mean number of embryos implanted in the right and left uterine horns were 2,4 and 4,5 respectively during September and October. The member of corpus between was 5 in each ovary.

VI. Social Engineering Activity on Rodent Control : Under the study the data gathered during the period revealed that under field conditions the number of live burrows in pre control census ranged from 0.90 to 21.25, 0.0-20.90 and 0.22 to 28.20/ ha in maintenance, neglected and survey area, respectively with mean of 10.16, 11.26 and 12.11/ha under varying situations. This showed low to medium activity of rodents. The control success ranged from 68.75 to 98.80% in maintenance and 25.00 to 92.8% in neglected area. The mean control success was 84.37 and 51.21% in fields under maintenance and neglected area. Thus, area treated in both the seasons gave higher percentage of control success than once.

ACHARYA N.G. RANGA AGRICULTURAL UNIVERSITY, A.R.S. MARUTERU

I Rodent survey : Rodent pest species composition in different cropping system of Andhra Pradesh are as follows:

(i) Fields crops: (a) Rice (Irrigated condition): *B. bengalensis*> Mus booduga (Upland condition): B. bengalensis> *Mus booduga*> *M. meltada*> *T. indica* (b) Pulses, Vegetables, Cotton, Bajra, Jower, Sunflower & minor millets : *B. bengalensis*> *M. booduga*> *M. meltada.* (ii) Plantation crops :

(a) Coconut : Nut infestation on plant - *R. rattus* worughtoni
Nut infestation in storage - *B. bengalensis*, *T. indica*
Seeding damage in nursery - *B. bengalensis*

(b) Oilpalm : Seeding damage - *B. bengalensis*

II. Reproductive biology of *Bandicota bengalensis* : The reproductive biology of *B. bengalensis* was studied based on field collected samples. Though this species breeds round the year, however the peak period was found to be October-November which coincides with the reproduction or grain hardning stage of the crop.

III. Rodent damage : In Godawari delta, nut damage due rodents in coconut grain ranges from 8-12% (Av. 10%) . Simulated rodent damage was standardised in rice crop. Among various crop growth stages, shoot romovel after 40 days of transplantation was more detrimental (38-45% loses in fields) as compared to 10, 20 and 30 days after transplant. In general yield losses were inversely proportional to the tiller damage levels. Similarly in black gram, bandicoots infected a loss (due to hoarding alone) to the tune of 22.43-48.0 Kg per hectare. IV. Rodent management : Evaluation of rodenticide against *B. bengalensis* in rice and *R. rattus* wroughtoni in coconut plantation were investigated in detail :

(a) *B. bengalensis* : (i) Out of three rodenticides tested, bromadiolone CB was proved to be effective and also economical when used during vegetative stage of the crop.

(ii) When aluminium phosphide pellets were evaluated against *B. bengalensis* during reproductive stage of the crop,1.2 g/burrow concentration was found to be effective.

(b) R. rattus wroughtoni : Against this rodent species bromadiolone (0.005%) cake formulation was proved to be effective. It was found that considerable yield reduction will not be there due to rodent damage to rice, even the damage continue upto panicle initiation stage. Yield reduction will be more if the damage occurs beyond panicle initiation stage.

V. Social Engineering activity on Rodent control : (i) Under the Social Engineering activity on rodent control, damage to rice can be contained upto 80% if the control operations are carried on area basis rather than on farmer basis.

(ii) As a member of the expert team constituted by the Commissioner and Director of Agriture, Government of Andhra Pradesh, the Centre organised several mass campaigns for containing the rodent menace. Besides this, training programmes to the needy farmers were organised regularly.

VI. Rodent Control schedules : Two schedules for the control of rodents in rice and coconut have been evolved by the centre. Both the schedules have been adopted as National Recommendation in the Principal Investigation meeting held at Ludhiana on 14.9.1995.

Rice:

Day 1 : Identify live burrows and simultaneously place 15 g freshly prepared bromadiolone loose bait in packet inside the burrow.

Day 11 : Repeat bromadiolone loose baiting in the active burrow.

Coconut :

Day 1 : At the time of nut harvest, place two bromadiolone cakes (0.005%) on either side of the crown close to the infested bunches - chicks about 80% nut infestation.

Day 31 : Repeat bormadiolone cake application to infested palm after one month of its baiting i.e. at the time of next month nut harvest - checks 100% nut infestation.

VI. Design & development of burrow fumigator : For the control of rodents a small compact unit, called Burrow Fumigator was designed and developed by the Centre. It involves burning of farm wastes like paddy straw leading to generation of smoke which is pushed into the burrow tunnel with the help of blower. Within 10-15 minute, all the tunnels of the burrow are filled with smoke and the pest rodents living inside die of suffocation.

GUJARAT AGRICULTURAL UNIVERSITY, JUNAGADH

I. Rodent survey : During the extensive survey, *R. rattus*, *R. cutchicus* and *M. musculus* were recorded in residential premises, whereas, *R. rattus*, *R. cutchicus*, *M. musculus* and *B. bengalensis* were found damaging the stored products in godowns. Similarly, the activity of *R. rattus*, *R. cutchicus* and *B. bengalensis* was also recorded in poultry farm. Amongst these species, *R. rattus* was found predominant in all these three habitats. The rodent activity was comparatively high (10.78 to 14.85 per cent) in houses and godowns during June-August, however, it was minimum (2.97 to 5.95 per cent) during the month of September.

Various rodent species are found damaging the field crops. The relative abundance of rodent species may vary with soil type, cropping pattern, irrigation facilities and other ecological conditions of different locations. *B. bengalensis* was found predominant in major groundnut growing areas (South Saurashtra and North Saurashtra agroclimatic zones) of Gujarat state and it was followed by either *T. indica indica* and *M. meltada meltada* or *M. meltada meltada* and *T. indica indica* conversely . *T. indica indica* was found predominant in Bhal and coastal area, north-west arid zone and north Gujarat - dry region agroclimatic zones and it was followed by either *B. bengalensis*, *M. meltada meltada* or *M. hurrianae*. In Sami, Tharad and Vav talukas of north-west arid zone and Dhanera taluka of North Gujarat - dry region, *M. hurrianae* was found predominant species followed by *T. indica indica*.

II. Rodent damage : In the study on extent of rodent damage in major crops of Gujarat state, 3.57 to 10.51, 1.92 to 10.12, 3.10 to 4.42, 1.85 to 17.14, 2.31 to 7.81, 3.67 to 6.63, 2.35 to 13.20, 2.71 to 18.46 and 1.93 to 19.89 per cent rodent damage was recorded in groundnut, pearl millet, sorghum, wheat, gram, sugarcane, cotton, pulses and vegetables, respectively.

III. Rodent management : Four different rodenticides viz., bromadiolone (0.005%) wax cake, cholecalciferol (0.075%) wax block, flocoumafen (0.005%) wax block and zinc phosphide (2%) poison bait were evaluated against field rats in groundnut and wheat crop upto 1993-94 and then flocoumafen was dropped from the studies because of its unavailability. These rodenticides were applied first at the time of sowing in both the crops and then at pod formation stage in groundnut and milky stage in wheat crop. 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 minimum number of live burrows at 3 days after treatment were recorded in zinc phosphide (2%) poison bait. Bromadiolone also gave significantly the highest rodent control success in groundnut (95.32 to 98.48%) and wheat (87.59 to 98.08%) crops and it was followed by cholecalciferol (0.075%) wax block and flocoumafen (0.005%) wax block. Further, significantly highest yield of groundnut (835 to 1265 kg/ha) and wheat (4155 to 4498 kg/ha) crop was also obtained in bromadiolone (0.005%) wax cake.

Among the three rodenticides evaluated in three poultry farms separately, bromadiolone (0.005%) wax cake was found superior in respect of reduction in rodent population (80.95 to 86.36%) and egg damage due to rodents (77.59 to 89.57%). However, it was followed by cholecalciferol (0.075%) wax block and zinc phosphide (2%) poison bait. *R. rattus* was found predominant species in almost all poultry farms.

IV. Management schedule for groundnut : Two applications of bromadiolone (0.005) wax cake, first at the time of flowering and second at pod maturity stage (ICBR

1:49.5) or first application of zinc phosphide (2%) poison bait at the time of flowering and second application of bromadiolone (0.005%) wax cake at pod maturity stage (ICBR 1:24.8) each @ 10 g poison bait/live burrow are effective for rodent management in groundnut crop.

OR

Two applications of bromadiolone 0.005% wax cake, first at the time of germination and second at pod formation stage (ICBR 1: 52.08) or first application of zinc phosphide 2% poison bait at the time of germination and second application of bromadiolone 0.005% wax cake at pod formation stage (ICBR 1:22.71) each @ 10 g poison bait/live burrow are effective for rodent management in groundnut crop.

V. Social Engineering Activity on Rodent Control : In social engineering activity, three villages namely (1) Prabhatpur as maintenance area, (2) Badalpur as neglected area, and (3) Jamka as survey area were selected in phase 2. Three different rodent species viz., *B. bengalensis*, *M. meltada meltada* and *T. indica indica* were observed during *kharif* and **rabi** seasons amongst which *B. bengalensis* was found predominant one. In maintenance area, significantly lowest plant (0.74 to 1.19%) and pod damage (0.66 to 1.72%) at different crop growth stages and higher yield of groundnut (865 to 1315 kg/ha) were recorded in *kharif* season. Similarly, significantly lowest plant damage at tillering stage (0.74 to 0.99%) and earhead damage at milky and pre harvest stages (0.64 to 1.93%) and higher yield (3770 to 4150 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. eduction in rodent activity in groundnut was recorded at flowering and pod maturity stage, respectively, however, it was reduced upto 83.63 and 86.34 per cent (mean values) at tillering and milky stage 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. Thus, training with demonstrations and rodent control campaign under expert's supervision had great impact on reduction of rodent activity as well as plant and pod/earhead damage in groundnut and wheat crops.

Farmers' motivation through training and education for rodent management and mass control campaign under expert's supervision was found to have great impact on reduction in rodent population as well as crop damage in groundnut and wheat in the villages selected in Ist phase and IInd phase.

DR. Y.S. PARMAR UNIVERSITY OF HORTICULTURE & FORESTRY, NAUNI (SOLAN)

I. Rodent survey : Survey was conducted in districts of Kinnaur, Shimla, Mandi, Bilaspur, Hamirpur, Una, Kangra and Sirmour and in all 10 species of rodents were collected and identified. Distribution and relative abundance of these species *vis-a-vis* elevation, crops/cropping pattern and agroclimatic regions have been established.

S.No.	Species	Distribution	Nature
1.	*B. bengalensis*	All agroclimatic zones upto 2500 mm above MSL	Major pest of cereal, vegetable and fruit crops; primarily a field species tending to become communal in Kinnaur.
2.	*R. meltada*	Humid sub-temperate, humid sub-tropical and sub-humid sub-tropical zones upto 1200 m above MSL	Major pest of cereals, vegetables and sugarcane; field species. Population dwindling.
3.	*R. rattus*	All agroclimatic zones	Commensal species, prepare nests using a variety of nesting materials. Frequently visits fields and is pest of all crops; occupies burrows deserted by other rats and also build nests.
4.	*T. indica*	Foot hills of district Solan only (humid sub-temperate and humid sub-tropical regions)	Field species; minor pest of vegetable and cereal crops. Population dwindling.
5.	*G. ellioti*	Humid sub-temperate, humid sub-tropical and sub-humid sub-tropical zones.	Field species in wastelands, grasslands and forests. Also recorded from vegetable crops and orchards; minor pest.
6.	*M. musculus*	All agroclimatic zones	Essentially a commensal species which is a major pest, alongwith *B. bengalensis*, of all crops-cereals, vegetables, fruits and tea plantations.

7.	*M. booduga*	All agroclimatic zones upto 2000 m above MSL	Field species, pest of nurseries, orchards, crop fields, tea plantations and grasslands.
8.	*M. platythrix*	Humid sub-temperate and humid sub-tropical regions	Field species, a minor pest of vegetable and cereal crops. Population dwindling.
9.	*Funambulus pennanti*	Sub-humid tropical and humid tropical regions.	Commensal species, pest of fruit trees and maize.
10.	*Hystrix indica*	Sub-humid sub-tropical and humid sub-temperate regions upto an elevation of 1500 m above MSL	Wild species, causes at times extensive damage to vegetable and tuber crops in the fields located near forests.

In fruit crops, *B. bengalensis* and *M. musculus* collectively constitute around 60% of total rodent fauna. In vegetable and cereal crops, *B. bengalensis*, *R. meltada*, *M. musculus* and *M. booduga* constitute around 80% of total rodent fauna.

II. Rodent damage : Rodents cause extensive damage in cereals (upto 14.86% in wheat, upto 8.5% in paddy), vegetables (upto 8.5% in cauliflower curd crop and upto 14.0% in cauliflower seed crop; around 4.0% in cabbage; upto 7.75% in pea and upto 6.5% in tomato), and fruits (upto 24.0% in apple nurseries and around 2.0% in apple trees; around 3.0% to peach and plum trees; and upto 17.0% to pecan nut plants; and around 5.0% to stored apples).

III. Rodent management : (i) Existing rodenticides (zinc phosphide and bromadiolone) and fumigant (aluminium phosphide) as well as new rodenticides (chocalciferol, racumin, flocoumafen and difethialone) have been tested in the laboratory and field for their acceptance and bio efficacy.

(ii) Cholecalciferol (0.075%) was effective against *B. bengalensis* but proved to be ineffective against mice in presence of alternative food in laboratory conditions. It was also ineffective in combating rodents in fields.

(iii) Difethialone (0.0025%) proved to be effective against *B. bengalensis* and mice (*M. musculus and M. booduga*) and resulted in upto 78% reduction in rodent activity in the fields.

(iv) Flocoumafen (0.005%) also proved to be an effective rodenticide against rodents resulting in 86% (approximately) reduction in rodent activity.

(v) Burrow baiting scored significantly over other modes of rodenticide application (such as broadcasting, surface baiting and bait boxes).

(vi) Pulse baiting provided better control (upto 94% success) of rodents than single baiting/treatment.

(vii) Live trapping and subsequent removal of trapped rodents for three consecutive days each month over one year, successfully reduces rodent activity by over 60%.

(viii) Based on studies, a plan for rodent management has been prepared and it forms a part of the "Package and Practices for Horticultural crops" published by Dr. Y.S. Parmar University of Horticulture and Forestry, Solan. Some salient points of the plan are briefed as under :

1. Habitat manipulation : Removal of litter and ground cover herbs, shrubs etc. and maintenance of sanitation in orchards results in over 25% reduction in pest population.

2. Trapping : Success upto 60%.

3. Rodenticidal baiting/aluminium phosphide fumigation.

III. TECHNOLOGY EVOLVED

Comprehensive schedule for rodent pest management : Based on the achievement made during previous year following recommendations may be made, to form a comprehensive schedule for management of rodents pests in various cropping systems, threshing floors and grain stores.

1. Rodenticides and their dosages

i. Zinc phosphide - 2.0 - 2.5% w/w bait

ii. Bromadiolone - 0.005% loose bait or wax cake

iii. Aluminium phosphide (fumigant) : It is generally recommended for the effective control of residual rodent population in crop fields. For its effectiveness, enough soil moisture should be available so that lethal phosphine gas is liberated in the burrows.

As per the decisions of the Central Insecticide Board and Registration Committee, aluminium phosphide would now be available for open sale in a new trilaminated LDPE/Aluminium paper pouch of 5.0 g packing. A 5.0 g pouch per burrow is also being approved for burrow fumigation. It is recommended for the management of residual rodent population in the crop fields and threshing floors only.

Schedule for lean periods : During May/June and October/November i.e. just before sowing or planting of the field crops, burrow baiting with zinc phosphide (2%) followed by bromadiolone (0.005%) should be adopted.

Schedule for crops

(a) Paddy, wheat, jowar, millets, sugarcane, pulses, oilseeds, vegetable crops

i. Zinc phosphide : (a) prebaiting with plain bait (10-15 g prebait per burrow) should be done prior to poison baiting. 2.0-2.5% zinc phosphide bait to be placed inside the live burrow @ 6-10 g bait per burrow). Bait should be prepared using commonly grown cereal and edible oil of the area , (b) since residual rodents population develop bait shyness after one baiting with zinc phosphide, a minimum of 50-60 days gap should be given before it is used again, and (c) for residual rodent population, bromadiolone (0.005%) baiting should be done @ 15 g bait per live burrow.

OR

ii. Bromadiolone : 0.005% bromadiolone bait (10-15 g per burrow) to be placed inside the live burrows or in the bait stations. Since there is no problem of bait shyness in rodents due to this poison, the baiting with bromadiolone may be repeated after 15 days for the control of residual rodent population.

OR

iii. Coumatetralyl: Studies at Punjab Agricultural University, Ludhiana centre shows that 0.0375% coumatetralyl as freshly prepared bait is good for the management of rodent pest in rice-wheat cropping systems of Punjab.

Timings for control operation in field crops : First treatment - before sowing for all crops. Second treatment should be done as follows :

rice	:	August
wheat	:	Mid February/ early March /at first at milky stage and repeat after 15 days if necessary.
Groundnut	:	Two treatments of bromadiolone (0.005%) - first at pod formation stage and repeat after 15 days.
Sugarcane	:	July-August and repeat in October-November.
Vegetable crops	:	Damage initiation stage.

(b) Coconut palms

i. Place 2 cakes of 0.005% bromadiolone each on either side at the base in the bunch bearing tender nuts.

ii. Repeat after 15 days on palms where fresh nut fall (damage) is noticed.

(c) Cocoa

i. Place 2-4 cakes of 0.005% bromadiolone on the forks of pod bearing branches. Bait station should preferably be secured to the branches.

ii. Whenever cocoa is intercropped with coconut, both crops should be treated simultaneously.

(d) Threshing floors

i. Place 10-15 g plain bait in the live burrows and follow it up with zinc phosphide (2.0 - 2.5%).

ii. Bromadiolone baiting after 15 days for residual rodent population.

OR

Bromadiolone (0.005%) poison baiting and repeat after 15 days if rodent activity is visible.

(e) Grain stores

Bromadiolone (0.005%) wax block or loose bait to be kept in the bait station in the areas of maximum rodent activity. Trapping inside the stores may also be resorted. Later on grain stores should be made rodent proof after controlling the rodents once. Bromadiolone (0.005%) baitings may be repeated as and when desired.

IV. SPECIAL PROBLEM AREAS

I. Rodent Upsurge in Sprinkler Irrigated Arid Areas

Churu district, located in the north - eastern tract of Rajasthan desert, represents a typical sandy undulated terrain formed by dunes and humocks. *Earlier, only rainfed* crops like *bajra, guar, moong* and *moth* were grown during *kharif* season. In recent years, groundwater has been explored in several areas and irrigated crops are being introduced by converting vast strecthes of undulated sandy areas under crop lands through sprinkler irrigation. New introductions during last 4-5 years are : groundnut (in kharif) and wheat, mustard, gram etc. (in *rabi*). During initial years farmers got satisfactory yields of groundnut. Gradually, rodents started invading the crop fields in large numbers causing serious losses. During 1998 Kharif groundnut experienced maximum rodent attack resulting in 30-65% loss in yields.

Systematic surveys and trapping in cropped areas in several villages of District Churu, Bikaner and Jaisalmer revealed that the desert gerbil, *Meriones hurrianae* was the major culprit constituting more than 80% of all rodent species. Other species like, *Gerbillus gleadowi*, *Tatera indica* and *Millarda meltada* were of minor significance in the cropped areas. Groundnut crop harboured about 40-50 live burrows per acre. Besides the losses to groundnut (30-65%), other rainfed crops viz. moth, mong, and cucurbit vegetables too recorded 10-50% rodent damage. A new behavioural manifestation of hoarding groundnut kernels in the burrow system by *M. hurrianae* was recorded for the first time. A maximum upto 2.5 kg of kernels were recovered per burrow. The loss of kernel due to hoarding alone was maximum upto 100-125 kg/ acre. Sprinkler irrigation is an ideal system for cultivating irrigated crops in such areas. Besides budgeting the overall water requirement, it covers the entire undulating fields also. However, sprinkler system has been helpful to field rodents as this system of irrigation never disturbs their habitat (burrow system) and provide conducive microclimate for desert rodents under groundnut plants leading to upsurge of pest population. In such areas farmers have to be very cautious for timely management of rodent pests before sowing the crops.

Majority of the farmers were not aware of the rodent management technology. Farmers showed keen interest in training programme on rodent pest management organised by us in village Alsar. Field demonstration on rodent management yielded 80-90% success in the farmer's field. Increasing threat of rodent menace to irrigated crops and our timely intervention have enormously helped in creating awareness against rodent pests among farming community of the area.

II. Rodent problem in Coastal Region of Andhra Pradesh

The cyclone during November 1996 in Godavari-Krishna Delta of Andhra Pradesh resulted in flash floods leading to rodent outbreak which is quite usual in the state. It is generally observed that rodents maintained a 10- year periodicity in their population upsurge in Delta- districts. ANGRAU, Maruteru Centre of the AICRP in collobration with Govt. of Andhra Pradesh and NPPTI Hyderabad surveyed the cyclone affected areas of the state. Some important observation of the survey are as under.

- Rodent pests normally start damage to rice crop from the maximum tillering stage i.e., around 6 weeks after transplantation. However, it was observed that rodent damaged tillers even in 3 week old crop and reports of 3-4 times replanting is common in East Godavari district. The crop damage is around 10-30% in all the affected fields. About 89,000 ha in East Godavari and 30,000 ha area in West Godavari were severely affected by the cyclone.
- The rodent control operations are mostly restricted to the bunds of the crop fields. The roads, railway lines, canal bunds, poramboke lands etc., are not covered. These areas served as major source of rodent infestation.
- Farmers complained about 5-10% nut damage to coconut also. As such publicity to take up rat control in coconut may avoid/reduce rat problem on coconut crowns. In Tanuka area the Sugarcane crop has shown rodent damage symptoms. Since rodent damage in rice is serious, sugarcane may also be affected subsequently in these areas.
- Rodent in the coastal districts start breeding in the post monsoon months, especially after September. However, presence of sub adults of both sexes indicated preponement of their breeding activity. A sample collection of 37 female rodents in rice fields were found pregnant/lactating. Such breeding at early stages of rice crop (4 weeks after transplantation) with sex ratio of 1:1 exhibited abnormal reproductive activity.
- Trapping with bamboo traps and smoking the rodent burrows are also reported by the tribals.

The team recommended following measures on a long term basis for effective management of rodent pests in coastal region of Andhra Pradesh.

Community awareness programmes : Awareness campaigns for the farmers may be organised through pamphlets, mass media including electronic channels, newspapers etc., highlighting the rodent menace in rice fields, especially after floods, cyclones etc.

Monitoring : Rodent control should be a continuing process in the Godavari delta since Rice-Rice-Pulse cropping pattern is normally followed. The field functionaries of

the Agriculture Department may include observations on rodent damage incidence and rodent infestation levels through live burrow counts in their periodic reports in order to monitor the rodent situation.

Coverage of No-Man's lands : In order to cover no man's lands viz., poramboke lands, road sides, canal bunds etc., the Commissioner of Panchayat Raj may be requested to issue necessary instructions to Gram Panchayats for provision of Rs. 3000-5000/- for bait material and campaign purposes.

Training/Educating farmers : The component of rodent control be included in the Kisan Melas, Krishi Vignana Vedikas organised by the State Government.

Relatively safer rodenticides : The usage of relatively safer anticoagulant rodenticide in two applications in summer period and at active tillering stage of the crop on regular basis may keep rodent pests in check under normal situations. The provision existing in ICDP for procurement of the chemical under IPM practices may be utilised.

Cyclone/Natural calamity funds : Since rodent resurgence follows after flash floods or cyclones in these areas, adequate funds may be earmarked for rodent control also under cyclone relief/natural calamity funds. This will ensure community participation covering whole village for effective rodent management.

III. Possible Rodent upsurge in NEH Region during Bamboo flowering

Director of Plant Protection Quarantine & Storage (GOI) and Indian council of Agricultural Research constituted an expert committee to suggest ways and means to contain the rodent menace in NEH region, with special references to possible rodent upsurge during 2005-2007 A.D. Some of the measures suggested for the rodent pest management in NEH region are as under.

- Use of local bamboo traps be encouraged both in crop fields and homestead.
- Use of second generation single dose anticoagulant rodenticide viz., 0.0005 bromadiolone ready to use cake or 0.25% bromadiolone concentrate is recommended for rodent control in crop fields and homestead. These are relatively safer rodenticidal formulation.

Details of use of rodenticides

Bromadiolone (0.005%) ready to use wax cakes : The cake formulation can be directly applied by breaking the slab of 100 gms. into six pieces. Each piece to be placed in live burrow or on the bunds at a distance of 5-10 mts. interval in the bait stations. The per hectare requirement of cake is 600 gms.

Bromadiolone 'BC' (0.25%) bait concentrate : Bait Concentrate should be mixed with cracked cereals (Rice/Wheat) in 1: 49 ratio. The preparation of bait is as follows :

- Take 480 gms. of bait material such as broken wheat/rice grains in a suitable container for mixing.
- Pour 10 gms. of groundnut oil on the bait material and mix thoroughly.
- Sprinkle 10 gms. of bromadiolone concentrate (0.025%) on the bait material coated with oil and mix thoroughly by rubbing with gloved hands or by using a seed dressing drum to ensure uniform coating of poison on the cereal baits.
- Prepare paper packets containing 15 gms. approximately (2 tea spoons) of prepared bait. Each packet may be use for one line burrow.
- The per ha. requirement of this concentrate is 12 gms.

Action Plan :

- Close all rodent burrows in and around the field form in the evening.
- Next day place one packet of bromadiolone bait containing 15 gms. approximately in each reopened burrow.
- After 15 days, close all the burrow openings again and on the next day, place one bait packet, if any, burrow is reopened.
- To prevent damage by the rat migration from adjoining fields bait stations at 10-15 mts interval around the crop fields. Bait stations can be made from locally available bamboo stem which notonly conceal the bait properly but allow easy access to rats also.
- Place approx. 50 gms of bromadiolone bait in each bait station which can be replenished after seven days whenever consumed.
- Zinc phosphide baiting may be done where there is outbreak of rodent for quick mortality. Prebaiting for 2 or 3 days is essential in case of zinc phosphide for making it acceptable to rodents. 2-2.5% zinc phosphide baiting is recommended for rodent control in field crops. Its bait can be prepared by mixing 1 kg of bait material (broken rice /wheat) with 20 gms of groundnut/coconut oil and 20-25 gms of Zinc phosphide powder. It should be followed by the use of 0.005% bromadiolone cake or freshly prepared bait to contain the residual rodent population.

Note : Use of zinc phosphide be discouraged in homesteads. Safer anticoagulant rodenticide, bromadiolone may be used as baits in such areas. The state extension functionaries should create awareness among farmers for safe use and handling of rodenticides.

V. TRANSFER OF TECHNOLOGY

Documentation

One of the major endeavours of the AICRP has been documentation of various research results in the form of reports, proceedings, mimeographs, monographs etc. RODENT NEWSLETTER, a quarterly publication of the project has provided a convenient medium for rodent workers round the country and abroad to disseminate interesting new observations and research results. Two special issues of Rodent Newsletter, one devoted to techniques of rodent research and other devoted to National Symposium on Rodent Pest Management, have created a special interest among readers. Some of the reports and monographs released by the P.C. Cell and respective centres of AICRP during the period under report are detailed below :

- Annual Progress Reports of the AICRP on Rodent Control.
- Proceedings of the All India Workshops held at different centres.
- Rodent Management - The State of Art.
- Chuhon se Hone Vali Samasya evm Samadhan.
- Fifteen years of Coordinated Research on Rodent Control.
- Rodent and other vertebrate pest management in coconut and cocoa.
- Rodent pests and their management in North Eastern Hill Region.

HUMAN RESOURCE DEVELOPMENT

Since rodent management technologies are easy to operate and are quick result oriented and cost effective, these can be translated into practice in the farmers fields. But, for proper transfer of technology, all the strata dealing with extension and education need to be invariably trained. The AICRP on Rodent Control has taken all the strata into consideration for training. The training may help in human resource development of rural masses. Following types of trainings are organised by the AICRP at different centres.

i. Apex Level Training : This training is imparted to the officials of Departments of Agriculture, Food, Health, Railways, Forests, Aviation etc. It is organised under the aegis of National Programme on Rodent Management formulated by Government of India during 1975. The Coordinating Centre of the Project at CAZRI, Jodhpur is organising this training course since its inception. In addition to this, the Acharya N.G.Ranga Agril. Univ.(Formerly APAU), Maruteru Centre also organises this training programme at Hyderabad/Maruteru in collaboration with Central Plant ProtectionTraining Institute, Hyderabad. Recently, the Barapani (Shillong) Centre of

the project has also been entrusted to organise such a course for the officials of North Eastern Hill states. Besides the technical know how on management of rodent pests, the contents of the courses also emphasizes the transfer of technology, type of training required for lower strata, man management, moulding the attitude and behaviour of the people towards rodent pest management and on effective communication. Two such trainings were organised, one at Acharya NG Ranga Agricultural University(formerly Andhra Pradesh Agricultural University), Agricultural Research Station, Maruteru and another at ICAR Research Complex for NEH Region, Barapani during the period under report.

ii. Field Level Training : All the AICRP Centres organise such trainings as off campus/ on campus for educating the farmers of adopted villages under various IVLP programmes/KVKs. Rodent control campaigns are also organised by the AICRP centres at village level during summers. Training about rodent pest management were also given through Kisan Melas organised by various cooperating centres from time to time.

iii. Media utilization : The Project Scientists utilise various media like, All India Radio, Doordarshan and Print media for imparting mass education about the problem of rodents and their management. Besides this the Jodhpur centre collaborated with Audio Visual Research Centre, Ahmedabad for preparation of two video films for U.G.C. net work.The Ludhiana and Bangalore Centres have also developed video films on rodent pest management for mass education.

iv. Resource Generation : AICRP on Rodent Control has been able to generate resources through testing of fibre optic (F.O.) cables against rodent damage. The Cables are being laid by Deptt. of Telecommunications, Railways, Defence organisation etc. During 1996-97 a sum of Rs 60,000 has been generated by the P.C. Cell.

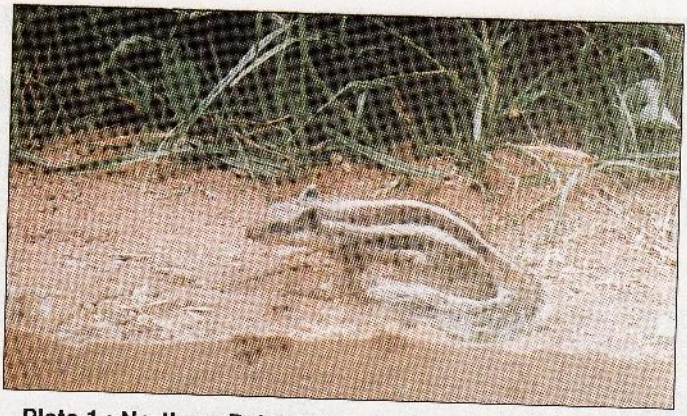

Plate 1 : Northern Palm Squirrel : *Funambulus pennanti*

Plate 2 : Lesser bandicoot rat : *Bandicota bengalensis*

Plate 3 : Field mouse : *Mus booduga*

Plate 4 : Rodent damage to Mustard crop

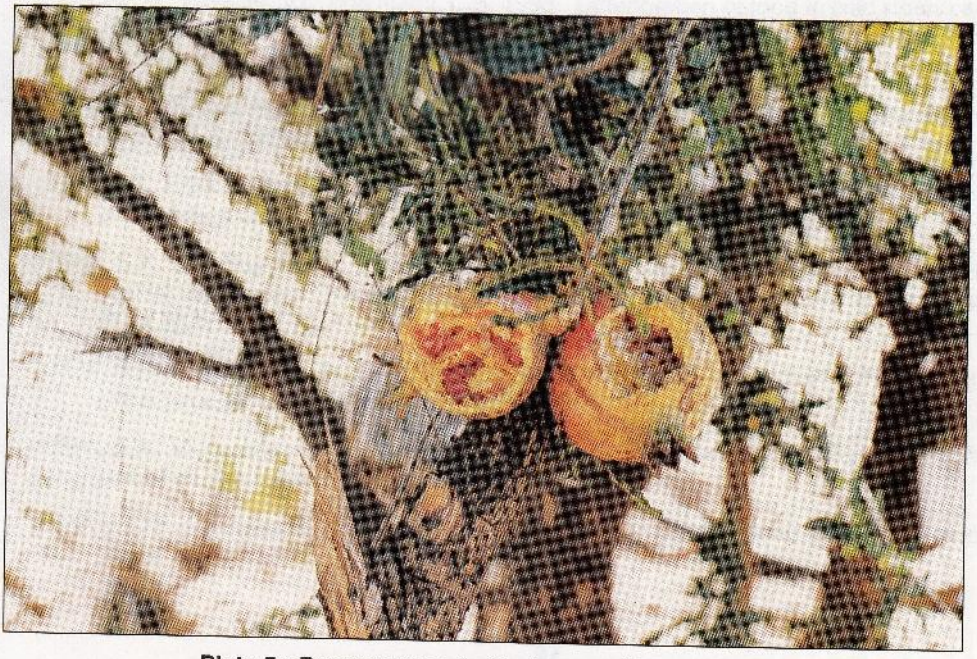

Plate 5 : Pomegranate fruits damaged by squirrels

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