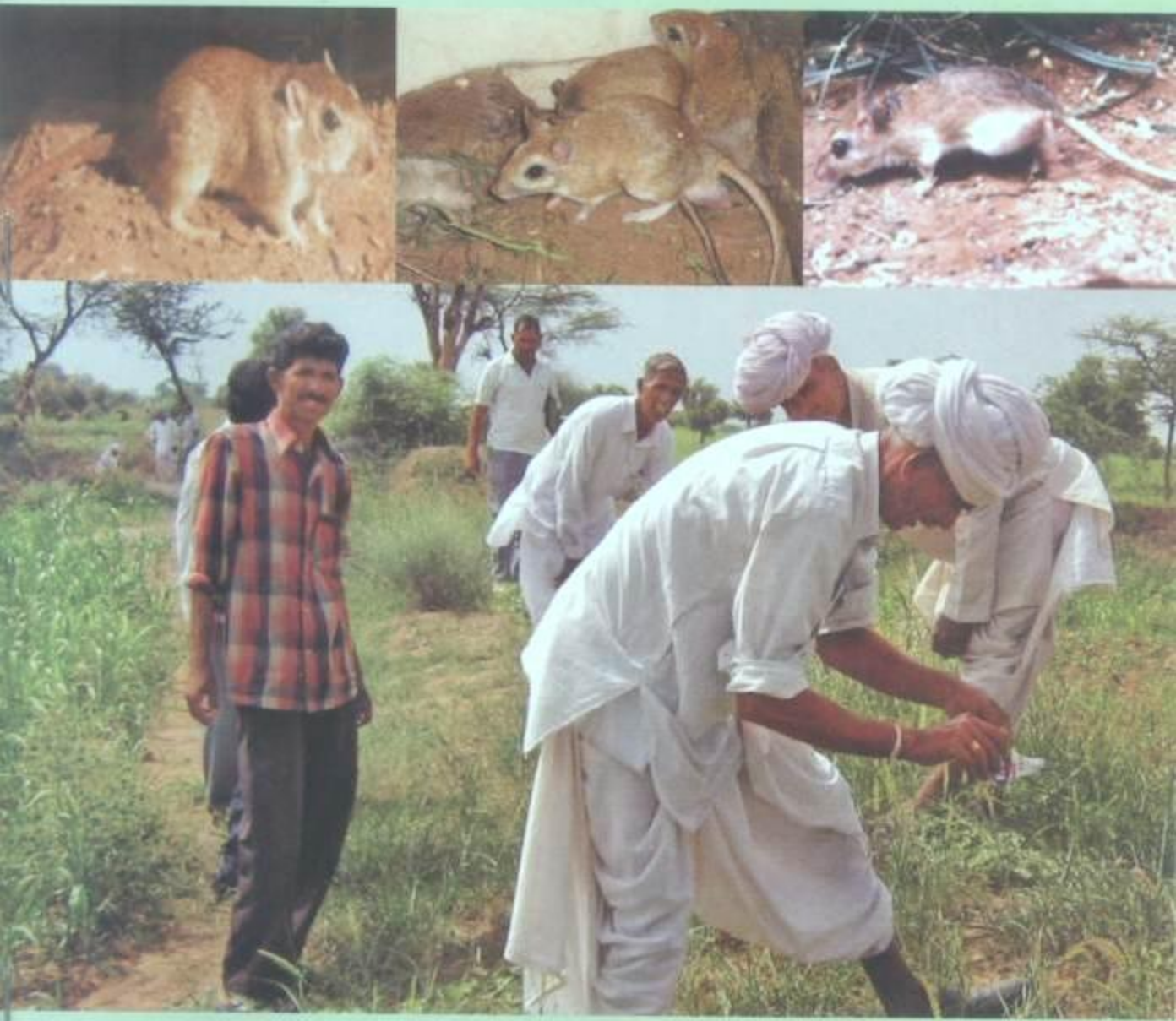
RODENT PEST MANAGEMENT

Dantiwada Experience



R.S. TRIPATHI AND BHAGWAN SINGH

All India Network Project on Rodent Control
CENTRAL ARID ZONE RESEARCH INSTITUTE
JODHPUR-342 003

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1. INTRODUCTION

Rodents are recognized as serious problem in crop production and storage world over. Out of over 100 species of rodents reported from India, only a limited number are regarded as pests in agriculture and storage. They form a very diverse group of mammals viz., porcupines, squirrels, rats, gerbils, mice, mole rats etc. Some rodent species are also responsible for spreading several dreadful diseases to man and livestock. Estimates of rodent damage to crops vary immensely depending upon the species, crop stage, agro-ecological region, availability of food and physical environment. With the introduction of farming system approach in arid and semi arid areas, the problem of rodents acquires a new dimension because annual and perennial crop components in the system together provide food and safe shelter to the native rodents on regular basis. Unlike insects rodent are very secretive and not easily observed because many of them are nocturnal. They infest an area throughout the year as compared to insects which appear only for short periods in certain seasons. Moreover rodents are highly mobile and a single individual may typically cause damage to several plants in one night by residing at some other place.

2. INDIAN ARID ZONE

Arid region in India is spread over 38.7 m ha area, of which 31.7 m ha is characterized as hot arid region occupying over 28 m ha in north western part of the country. It is mainly the eastern part of the Thar Desert covering about 62% area in 12 districts of western Rajasthan followed by Gujarat (19.6%), Haryana (4.0%) and Punjab (4.6%). Rest hot arid region is represented in Andhra Pradesh (6.9%); Karnataka (2.7%) and Maharastra (0.4%). Low and erratic rainfall, extreme temperatures (-5.7 to 50.0°C), long sunshine duration (6.6-10 hours), low relative humidity (30%-80%), high wind velocity (9-13 kmph) and high evapo-transpiration (1600-1800 mm) are characteristic features of the region. The soils are poor in nutrients; frequent droughts and wind erosion are most common in the region. Indian Thar is one of the most densely populated deserts of the world. Human and livestock population is consistently increasing. During the last 20 years, human population has increased by 50% and that of livestock by 25%. Such an increase in population is leading to greater exploitation of natural resources, which are otherwise quite meager in the region. Agriculture and Animal husbandry are the two main occupations of desert people. To meet the food and fodder requirements, farmers have adopted rainfed farming, development of range/ gochar lands, arid horticulture and tree plantations. Arable farming, horticulture and management of range/ gochar lands for livestock production, and silviculture/ forestry provide sustainability to the region and form the back bone of rural economy. The western Rajasthan supports a good faunal diversity, where rodents, largest group of mammals are represented by 18 species. Rodents being herbivorous are always a potential threat to various production systems (agriculture, horticulture, forestry and range lands etc).

3. CROPPING PATTERNS IN WESTERN RAJASTHAN

Based on rain fall and cropping pattern, Rajasthan State is divided in nine agroclimatic zones and arid regions spread in 12-13 districts cover four such zones viz., Zone I A (Arid western plains); Zone I B (Irrigated north western plains) Zone II A (Transitional plains of inland drainage and Zone II B (Transitional plains of Luni basin).The agro-economy of the arid region is mainly livestock based farming system. Thus a vast stretch of land, especially in Jaisalmer, Barmer, Jodhpur and Bikaner districts are under perennial forage grasses or gochar lands. Major range grass species in the region are *Cenchrus ciliaris*, *C. setigerus* and *Lasiurus sindicus*. Besides these grasses, foliage of several native bushes and trees (*Ziziphus nummularia* and *Prosopis cineraria*) are used as good source of animal feed. The agriculture in arid region is mainly rainfed, therefore only one crop is taken that too in monsoon season. The major crops traditionally grown in the region during *kharif* are – pearl millet, green gram, moth bean, cluster bean, sesame, cucurbits etc. With the advent of canal irrigation through Gang canal, Indira Gandhi Nahar, Jawai canal etc. and increased exploration of ground water resources, the area under irrigated crops like, groundnut, pigeon pea, castor, cotton, sugarcane, chickpea, cumin, isabgol, mustard etc is on increase. The most predominant cropping pattern of the region are: (i) pearl millet-green gram –moth bean-sesame-cluster bean (as rainfed) and cotton and groundnut (irrigated) in *kharif* season and (ii) wheat-mustard-cumin-chickpea, (irrigated) in *rabi* season. Among vegetable crops, solanacious vegetables (tomato, brinjal and chillies) and cucurbits are most commonly grown in the region. Jujube is the most important fruit crop of the region, however, in recent years farmers have also started growing pomegranate, kinnow, amla, date palm etc. under limited irrigation.

4. RODENT PROBLEM

4.1. Characteristics of rodents

Rodents belong to order Rodentia of class Mammalia. These small mammals are characterized by a pair of very sharp "chisel" shaped ever-growing incisors in each jaw. The incisors grow at a rate of about 0.4 mm/day. The canine teeth are absent leaving a wide gap between incisors and grinding teeth called diastema. In order to maintain the size of the ever-growing incisors, rodents nibble whatever hard substance they find in their habitat resulting into extensive damage to fields crops, stored grains/ commodities and several other household articles. They are omnivorous/cannibalistic and highly adaptive, mostly nocturnal and have well developed sense of smell, hearing and touch. Besides this, their fast breeding potential makes them to maintain high population levels in any habitat. Some characteristics features of breeding biology of rodents are presented in Table 1.

Table1. Breeding Biology of Rodents

Age at puberty	6-16 weeks
Estrous cycle	3-7 days
Duration of heat	9-24 hours
Mating habit	Promiscuous
Gestation period	18-30 days
Breeding season	Year round
Litter size	1-22
Post partum heat	4-96 hours
Breeding potential	800-1200 /pair/year
Life span	1-4 years

4.2. Rodent Pests of Arid Region:

In India the order Rodentia (Class: Mammalia) includes over 103 species grouped under six families. Extensive surveys in different parts of arid region of Rajasthan have revealed occurrence of 18 rodent species belonging to three families viz., Sciuridae (squirrels), Hystricidae (porcupines) and Muridae. Of these, former two families are represented by one species each and Muridae family comprising of gerbils, rats, mole rats and mice is represented by 16 species. Of the eighteen species of rodents encountered in arid zone, only 7-8 species may be considered as pests in agriculture, horticulture, forestry, grass lands and storage. A species complex of 3-4 species is reported to inflict economic damage in any particular crop/ cropping system. Both the gerbils, viz., Indian desert gerbil, *Meriones hurrianae* and Indian gerbil,*Tatera indica* are regarded as most predominant pests in rain fed as well as irrigated arable cropping systems of arid regions. Besides these, soft furred field rat, *Millardia meltada and* Indian field mouse, *Mus booduga* prefer to inhabit irrigated croplands and hairy footed gerbil, *Gerbillus gleadowi* is a pest of rainfed crops grown on dunes/interdunal spaces. The five striped squirrel, *Funambulus pennanti* occupies the trees scattered in the crop fields and the bush rat, *Golunda ellioti* prefers the thickets of the bushes commonly found on the periphery of the crop fields. A brief account of major pest rodents is given as under;

4.2.1. The field rodents

i. The Five striped or Northern palm squirrel, *Funambulus pennanti:* It is a medium sized rodent (90 g) with a bushy tail. The dorsal side is greyish brown with five distinctly white stripes separated by four off white bands. It is diurnal and peaks of activity occur in the morning and early evenings. The squirrel nests in holes in tree trunks and crevices in the walls of buildings, windowsills and is pest of vegetable and fruit crops and kitchen gardens. It breeds round the year with peaks during March–April and July-September in Rajasthan with a litter size of 1-5.

ii. The Indian gerbil, *Tatera indica:* It is a medium sized rodent weighing 70 to 150 g. Its tail is covered with hair, which terminates as a tuft at the tip, a characteristic feature of all gerbils. It is a nocturnal animal and inhabits open plains, loose sandy soils of the desert, and is usually found at the edges of cultivation. Burrows are dug near hedges, thickets or under bushes, sometimes inside the field also when conditions are dry. *T.indica* breeds throughout the year in arid Rajasthan with maximum littering in the month of August and a minor peak in February with a litter size of 1-9.

iii. The desert gerbil, *Meriones hurrianae:* It is a true desertic species and is restricted to arid tracts of Rajasthan and adjoining Haryana, Punjab and North West Gujarat. In Rajasthan it is widely distributed in sandy areas and well adopted to survive the extremes of arid climates. Its body colour is sandy grey to brownish grey dorsally and white to off-white ventrally. Tail is pale with dark brown tussle of hair at the tip. These gerbils are diurnal and inhabit cropfields, grasslands, waste lands, thorny forests etc. Females breed throughout the year with two peaks in February and July but a third peak is also observed during September-November.

iv. The hairy footed gerbil, *Gerbillus gleadowii* and *G. nanus Indus*: Both the species of Genus *Gerrbillus* are true desertic rodent fauna and therefore occur only in extreme desertic tracts in Jaisalmer, Jodhpur, Barmer, Bikaner, Churu, Sikar and Jhunjhunu districts in Rajasthan. These are small sized rodents and inhabit duny, hummocky or inter-dunal plains. Both the species have two breeding seasons in a year i.e. winter and summer months. It is regarded as pest of rainfed crops.

v. The short tailed mole rat, *Nesokia indica*: The species is relatively large sized (>200 g) with heavily built body and grayish brown colour. Very short tail of the animal and soil mole hills present near its burrow openings gives it the name 'short tailed mole rat'. It prefers bunds in cultivated fields along water channels but also occurs in natural vegetation. It is a very shy rodent with nocturnal and fossorial habits. In orchards and afforestation areas in Rajasthan its burrow openings plugged with excavated soil mole hills can be seen near base of fruit or forestry trees and all the openings are interlinked under ground. It breeds mainly during winter months with a litter size of 1-6.

vi. The soft furred field rat, *Millardia meltada*: It is a medium sized (weighs 40-60 g) field rodent with a very soft fur. Body colour light to dark grey dorsally with foot and belly being off white. Tail is naked with annular rings similar to body colour with dark grey above and pale below. It is distributed throughout Rajasthan in irrigated crop fields, scrub grassland, sandy plains and is therefore regarded as sub-mesic rodent fauna. In Rajasthan this species breeds throughout the year with peak reproduction occurring in monsoon and spring season.

vii. The Indian field mouse, *Mus booduga*: It is a small rodent weighing 10-15 g. Dorsal fur on the body including tail varies in colour from pale sandy or dark brown to greyish and the ventral side is pure white, thus the tail looks bicoloured. It is a ruderal species and occurs in and around irrigated crop fields throughout India. It breeds throughout the year except during very cold months.

4.2.2. The commensal rodents

i. The House rat, *Rattus rattus* : It is a medium sized rat weighing 100-150 g. It is the most abundant and widely distributed rodent in the world. The species is characterized by long tail, black coloured dorsal surface with slender body and pointed snout. It is a commensal species living in houses, godowns, stores, poultry farms, crop fields, adjacent to villages and causes serious losses to stored commodities. It breeds round the year.

ii. The house mouse, *Mus musculus* :The house mouse is a tiny animal weighing 15-20 g. Tail is naked and longer than body length. Dorsally, the colour varies from brown to light brown with belly being whitish to light gray. It is mainly a commensal species but in recent years it is being reported from fields also. The mouse also breeds round the year with a litter size of 1-8.

4.3. Rodent damage:

The rodent population being high in the desert and their demand for food being insatiable, these pests maintain an appreciable pressure on the desert croplands, grasslands and afforestation plantations causing serious losses. Pearl millet, the staple food of desert people suffers to the tune of 2-5 % rodent damage. The crop experiences maximum loss when harvested crop is heaped in the fields and the gerbils follow the cobs by

digging tunnels under the heap and feed on the cobs. The arid pulses viz., moong and moth bean too experience around 3% pod damage. In chillies these pests damaged 15-20 kg fruits per ha. Wheat experienced 11-21% damage due to rodents. Mustard suffers about 22.9-43.5% reduction in plant stand in the peripheral areas of the crop fields. Groundnut cultivation has suffered a major setback in arid regions due to rodent devastations (30-50%) during the last few years. Among vegetables, tomato, carrot and raddish are damaged to the extent of 16-30 percent by rodents. Cucurbits recorded 4.1% fruit damage resulting in yield loss of 6.5 q/ha. Similarly, the fruit crops viz., ber, pomegranate etc are also not spared by rodents. Squirrels are reported to cause a loss of 29% of ripe fruits of pomegranate. Similarly, date palm at ripening stage suffers 60-80% squirrel damage. Rodents have great preference for fodder grasses like *Cenchrus ciliaris, C. setigerus* and *Lasiurus sindicus* growing in the arid rangelands. The desert gerbils dig out the sown seeds and feed on them almost to the roots of the fodder. Similarly, 4-10 percent damage has been recorded in desert forestry plantations of *Acacia tortilis, Prosopis juliflora,* and *Acacia nilotica.*

5.0. DANTI WADA VILLAGE – A CASE STUDY

5.1. Genesis:

The arid land farming is continuously challenged by many abiotic problems which are inbuilt in arid regions leading to poor agricultural productivity. Pests like insects, diseases and rodents further affect the productivity. In view of serious losses caused by rodents in arid production systems, it becomes important to manage these vertebrate pests effectively for increasing the productivity of rainfed crops. The All India network Project on Rodent Control at Central Arid Zone Research Institute, Jodhpur has evolved effective rodent management strategies by developing simplified baiting techniques. It has been generally observed that the arid zone farmers are not fully aware of the rodent management technologies. It was therefore felt that the technologies need to be popularized among the farmers of arid zone. A four year project entitled "Popularization of selected CAZRI Technologies for strengthening production system in Dantiwada village of Jodhpur District" was taken up during 2006-2009 and transfer of rodent management technology was a major component of the study.

5.2. Dantiwada village:

Dantiwada village (Panchayat Samiti :Mandor) is located 35 Km from District Head quarter Jodhpur. The population of the village is 2037 with 400 families (2001 census). Total area of the village is over 2000 ha wherein more than 1500 ha is cultivable and 89 ha is under pasture. The farmers practice rainfed cropping during monsoon/kharif season. Bajra, mung, moth, guar, sesame and jowar (as fodder) are the major crops. Very few farmers grow mustard and wheat in rabi season under conserved moisture. The farmers practice traditional methods of cultivation resulting into very low productivity of these crops. Majority of the farmers are not well aware of the improved crop production technologies.

5.3. The Approach:

A multi pronged approach was adopted for popularization of rodent management technology in the study village. Five 'Group Discussions', four 'On farm trainings' and 18 Field demonstrations were conducted in the village/ farmers fields. Besides, distribution of literature and one 'Field Day' was also organized in the village which was attended by over 100 farmers of Dantiwada and neighboring villages for creating awareness about the rodent problem and its management.

5.4. The Technology:

5.4.1. Rodenticides:

Use of rodenticides is most common and expedient method to manage pest rodents and have shown greater scope in large-scale control operations. Zinc phosphide, recommended at 2% concentration in cereal baits is the most widely used rodenticide in India. It yields around 60% control success within 24 hours. High toxicity to non-target species and development of bait shyness/poison aversion in the target species due to its sub-lethal consumption are the major limitation in its repeated use. Bait shyness persists for more than 2-3 months in different rodent species. Because of high toxicity, zinc phosphide is recommended for field rodents only, when the rodent infestation is very high. For controlling the residual rodents (surviving after zinc phosphide treatment) alternate rodenticide i.e., bromadiolone (0.005%) in cereal baits is recommended. Since bromadiolone is very effective as single dose rodenticide also, therefore instead of double baiting with zinc phosphide followed by bromadiolone, single baiting with bromadiolone is also recommended. It can be used repeatedly depending upon the need, because it does not induce bait/ poison shyness in the rodents. Moreover bromadiolone can be effectively antidoted with vitamin K, in case of accidental consumption by humans.

5.4.2. Baiting Technology:

Preparation of rodenticidal baits is an important aspect of rodenticidal application technique, which is often overlooked. The proportion of toxicant to bait should be maintained properly. Too heavy dosages may repel the pest and with too light dosages rodents may stop eating before consuming the lethal dose resulting into development of bait shyness. Similarly the toxicant should also be uniformly distributed through the bait mixture rather than left as distasteful clumps. Since the rodneticides are available in powder form, use of most preferred cereal and oil component of the bait is of utmost importance. AINP on Rodent Control, CAZRI, Jodhpur has developed a very effective, easy and economic technique of bait preparation, which is briefed below;

(i) For zinc phosphide (2.0%): Zinc phosphide, being acute poison, is to be used in baits after a 1-2 days pre-bating only. Pre-baiting helps in acclimatizing the rodents on a new food at fixed location i.e., in the live burrows or bait stations, thereby increasing the acceptability

of poison baits and higher control success with reduced bait shyness problem. The pre bait and poison bait can be prepared as given below.

(a)*Pre-bait material:* (for one Kg of bait)

i. Take 960 g of pearl millet grains

ii. Mix 20 g groundnut oil in pearl millet grains with bare hands.

(b)*Poison bait:* (for one Kg bait)

i. Prepare pre-bait as suggested above.

ii. Sprinkle 20 g of zinc phoshpide and mix these ingredients with wooden stick till uniform mixing is achieved. (no house hold utensil be used for this purpose).

iii. Use any plant leaf as applicator for bait placement inside the burrows.

(ii) For Bromadiolone (0.005%): It is a chronic poison and the rodents die from 3-15 days of poison bait intake. No pre-baiting is required. The poison bait can be prepared as given below:

i. Take 960 g of pearl millet grains/ broken wheat

ii. Mix 20 g Ground nut oil.

iii. Sprinkle 20 g bromadiolone concentrate powder (0.25%).

iv. Mix these ingredients in a container with wooden stick (no house hold utensil be used for this purpose).

v. Use any plant leaf as applicator for bait placement inside the burrows.

The baits (@ 10 g/ burrow) are to be rolled deep in side the live burrows.

5.4.3. Safety precautions:

Rodenticides, if handled carefully and sensibly, should present no risk to other animals or people including the operator himself. Following precautions should be followed to avoid any risk.

(a) No eating, drinking or smoking should take place when live or dead rodents or poison baits are handled. All cuts and abrasions on the hands and arms should be covered before starting the work.

(b) Poison baits should be prepared in well-ventilated room and care should be taken not to breathe in or absorb any poison. After poison bait preparation and field application, hands should be washed with soap properly. The poison bait should not

be touched with bare hands. Any broad leaf or spoon or gloves, if available, should be used.

(c) All poisons (pure chemicals, baits, etc.) should be clearly labeled 'POISON' and held in a locked almirah and should be away from the reach of children.

(d) When poison baits are laid, the residents/owner of the area should be cautioned about the treatment so that children, livestock and pets can be kept away for a day to two.

(e) While placing the baits in the burrow, the poison baits should be rolled deep in the burrows to protect birds, livestock and other non-target species.

(f) After the control operation, the leftover baits and dead rodents, should be collected and buried deep in the soil.

6.0. FINDINGS

Four year long scientific interventions in Dantiwada village was very encouraging in creating awareness about rodent problem and popularizing the rodent management. Farmers participated in a big way in various programmes viz., trainings, group discussions and field demonstrations.

6.1. Farmers Training:

As part of capacity building and awareness creation four 'On farm farmers' trainings on 'Rodent Management' were organized in the village during 2006-09. The trainings were conducted mainly in participatory and interactive mode. The farmers were exposed about, the rodent pest species of the region; rodent problem in agriculture, storage and public health; diagnostics of the problem; rodent control techniques; rodenticides and bait preparation, applications and precautions in handling rodenticides. More than 150 farmers participated in this programme.

On Farm Trainings showed a considerable impact on the knowledge gain of farmers which was evident from assessment of knowledge before and after the training (Table 2). The study revealed that majority of the farmers (58.4%) were under low knowledge levels

(<33%) followed by 33.3 % with medium knowledge levels (34-66%) before the trainings. Only 8.3% were having knowledge above 66% before trainings. After the trainings the trend was reversed when knowledge of majority of farmers (62.5%) came under medium and 25% farmers reached to high knowledge group as against only 33.3 and 8.3% respectively before training. Similarly, the share of farmers with low knowledge was drastically reduced from 58.4 to 12.5% after training. Thus irrespective of the category over all mean knowledge increased from 35.5 (pre-training) to 65.5% (post- training).

Table 2: Impact of On Farm Training on Knowledge gain (%)

S.N.	Knowledge Levels	Before Training	After Training
1	Low (< 33%)	58.4	12.5
2	Medium (34-66%)	33.3	62.5
3	High (>66%)	8.3	25.0
4	Over all Mean	35.5	66.5

6.2. Group Discussions:

Five group discussions were organized on rodent control. These discussions were conducted in a group of 5-8 farmers. Under this programme, the farmers were given practical exposures about diagnosis of rodent damage to crops and identification of live burrows. Importance of community action for sustainable rodent management was explained to the farmers. Farmers prepared the poison baits themselves and applied in the burrows of selected fields under our guidance. In all 98 farmers/farm women were benefited through this exercise.

6.3. Field Demonstrations:

Besides rodenticiadal bait preparation and applications, the field demonstrations included practical exposure of the farmers about identification of rodent burrows of both the rodent species in and around crop fields and also the live pest rodents. Assessment of rodent infestation and efficacy of poison bait treatments (based on live burrow count) was also

demonstrated. The demonstrations were conducted for four years (2006-09), however the crops failed due to severe drought during 2006. The results of the three year field demonstrations (2007-09) are detailed below:

6.3.1. Rodent Pest Species:

Three year surveys during *kharif* season revealed that out of eighteen species occurring in western Rajasthan, only two species, the Indian gerbil, *Tatera indica* and Indian desert gerbil, *Meriones hurrianae* were the predominant pest rodents in the crop fields (bajra, mung, moth, sesame and guar) of Dantiwada village. The level of infestation in crop fields was from 51-57 burrows per ha. In the rural houses also only two species i..e., the house rats, *Rattus rattus* and house mouse, *Mus musculus* were observed. Burrowing patterns of both the rodent species and trapped rodents were practically demonstrated to the farmers.

6.3.2. Rodenticidal Treatments:

Two rodenticides, viz., zinc phosphide and bromadiolone under three treatments were selected for field evaluation in rainfed crops (bajra, mung, moth, sesame and guar) during kharif season (2007-2009). The treatments (i) zinc phosphide (2%) (ii) bromadiolone (0.005%) and zinc phosphide (2%) followed by bromodialone (0.005%) were applied in bajra (during 2007-09); moth (during 2008) and mung (during 2009). In guar (during 2007 and 2009) and sesame (during 2008) only one rodenticide (zinc phosphide) was evaluated. An untreated control was also kept for each crop for comparison. For preparing the baits bajra grains and ground nut oil was used following the methods explained in previous pages. The baits (bajra and oil) were contributed by farmers whereas the rodenticide was supplied by CAZRI and poison baits were prepared by the farmers.

6.3.3. Field efficacy of rodenticides:

The results of the three year long field demonstrations as depicted in the Table 3 indicated that on 4th day after treatment mean reduction in rodent infestation with single treatment of zinc phosphide was 57 to 65 %. The crop wise rodent control success was 64.8, 64.6, 62.2, 57.2 and 57.7% in bajra, mung, moth, sesame and guar respectively. On the other hand, single baiting with bromadiolone (0.005%) yielded significantly lower mean control success of 25 to 27 % on fourth day after treatment. In fact bromadiolone being an anticoagulant rodenticide has chronic action on target species and therefore mortality of rodents with bromadiolone treatments starts after 3-4 days of baiting and continues up to 10-12 days. That is why the control success increased up to 75-78 % with in two weeks of treatment with bromadiolone. Acute action of zinc phosphide, although yielded quicker success on 4th DAT but it registered decreasing trends from 64.8 to 56.2% (in bajra); 64.6 to 60% (in mung), 62.2 to 59.1% (in moth); 57.7 to 51.1% (in guar) and 57.2 to 50% (in sesame) with in two weeks.

The double treatments i.e. zinc phosphide baiting followed by bromadiolone baiting fetched highest mean rodent control success of 81.7 % (bajra), 84 % (moth) and 82.7 % (mung) on 15th day after treatment. Further probe into the results revealed that although the overall success with single treatment with bromadiolone and double treatments was at par (75-78%) in bajra, moth and mung crops, the double baiting (integration of acute and chronic rodenticides) seemed to have an edge over other treatments. Actually zinc phosphide being acute yields quicker results and follow up treatment with chronic bromadiolone further results in sustained management of rodent pests (Table 3).

The rodent pest population showed increasing trends in the untreated control fields of all the crops due to immigration from surrounding areas. In the treated fields the immigrating pest populations were also managed due to sustained effects of anticoagulant rodenticide baiting.

6.3.4. Effect of rodenticidal treatments on crop yields:

Data presented in Table 4 indicated that rodenticidal treatments had direct impact on yields of all the test crops due to management of rodents. The mean seed yield increases by 26.80 percent in moth followed by bajra (22.4%), mung (19.5%), sesame (17.7%) and guar (14.0%) due to rodenticidal treatment over the control.

The study revealed that the application of zinc phosphide (2%) followed by bromadiolone (0.005%) in bait form prepared with pearl millet grain using groundnut oil as additive may be recommended for management of rodent pests in kharif crops.

Table 3. Effect of rodenticidal treatment on rodent control success in Dantiwada village (2007-2009)

Crops	Treatments	3-year Mean No of burrows (per ha)	Control success (%) 2007		Control success (%) 2008		Control success (%) 2009		Mean control success (%)	
			4 DAT	15 DAT	4 DAT	15 DAT	4 DAT	15 DAT	4 DAT	15 DAT
Bajra	Zinc phosphide	49.3	62.2	60.0	65.4	53.8	66.7	54.9	64.8	56.2
	Bromadiolone	55.0	23.1	71.2	28.6	78.6	29.8	75.4	27.2	75.1
	Zinc phosphide + Bromadiolone	53.3	58.3	80.6	60.9	81.2	58.3	83.3	59.2	81.7
	Control	44.3	-7.1	-14.2	-6.3	-22.2	-8.7	-19.6	-7.4	-18.7
Moth	Zinc phosphide	63.5	-	-	62.5	61.1	61.9	57.1	62.2	59.1
	Bromadiolone	55.0	-	-	23.7	78.2	-	-	23.7	78.2
	Zinc phosphide + Bromadiolone	50.0	-	-	70.0	84.0	-	-	70.0	84.0
	Control	53.0	-	-	0.0	-15.6	-4.2	-10.0	-2.2	-12.8
Mung	Zinc phosphide	65.0	-	-	66.2	63.1	63.1	56.9	64.6	60.0
	Bromadiolone	55.0	-	-	-	-	25.4	78.2	25.4	78.2
	Zinc phosphide + Bromadiolone	52.0	-	-	-	-	71.1	82.7	71.2	82.7
	Control	52.0	-	-	-4.2	-8.4	0.0	-16.1	-2.1	-12.3
Guar	Zinc phosphide	61.5	58.5	50.8	-	-	56.9	51.7	57.7	51.3
	Control	53.5	-3.7	-11.1	-	-	0.0	-9.4	-1.8	-10.3
Sesame	Zinc phosphide	56.0	-	-	57.2	50.0	-	-	57.2	50.0
	Control	58.0	-	-	0.00	-4.9	-	-	0.0	-4.9

Zinc phosphide (2%) and Bromadiolone (0.005%) in bajra baits.
DAT: Days after treatment

Table 4. Effect of rodenticidal treatments on yield of kharif crops in Dantiwada village (2007 & 2008)

Crop	Treatment	No of burrows treated (per ha) 2 year mean	Yield kg ha $^{-1}$ 2007	Yield kg ha $^{-1}$ 2008	Mean yield kg ha $^{-1}$	Increase in yield (%)
Bajra	Zinc phosphide	48.5	630	970	800	22.14
	Bromadiolone	54.0				
	Zinc phosphide + Bromadiolone	50.0				
	Control	43.5	460	850	655	
Moth	Zinc phosphide	64.0	-	520	520	26.80
	Bromadiolone	55.0				
	Zinc phosphide + Bromadiolone	50.0				
	Control	56.0	-	410	410	
Mung	Zinc phosphide	65.0	-	550	550	19.50
	Control	48.0	-	460	460	
Guar	Zinc phosphide	65.0	320	-	320	14.00
	Control	54.0	280	-	280	
Sesame	Zinc phosphide	56.0	-	530	530	17.70
	Control	58.0	-	450	450	

Zinc phosphide (2%) and Bromadiolone (0.005%) in bajra baits

6.4. Field day:

One field day on improved technologies of kharif crops was organized on 30th August 2008 in Dantiwada village. Lectures on rodent management were delivered and beneficiary farmers expressed their satisfaction in adopting theses technologies with the active support of CAZRI. About 102 farmers/ farmwomen from Dantiwada and nearby villages participated in this programme.

7.0. FEED BACK FROM FARMERS

7.1. Success of technology:

Majority of the farmers (69-84%) reported that rodents cause serious losses to crops and adoption of rodent management technologies has resulted in successful management of rodents in their fields and thereby increased yield could be obtained.

7.2. Adoption of Technology:

Opinion survey of the farmers revealed that majority of the farmers (92.5%) showed low to medium adoption levels before the initiation of this programme in the village. Only 7.5% farmers were adopting the technology (>66%). Over all mean of adoption level was only 20.4%. However after the introduction of the programme, 25% farmers not only reached to high adoption levels but a majority of the farmers (60.0%) elevated to medium category of adoption. Only 15.0% opined about low adoption. Thus due to introduction of the programme, overall mean adoption levels increased from 20.4 to 50.7 percent (Table 5).

Table 5: Adoption Level (%) of farmers regarding rodent management technology

SN	Adoption Levels	Before Programme	After Programme
1.	Low (< 33%)	60.0	15.0
2.	Medium (34-66%)	32.5	60.0
3.	High (>66%)	7.5	25.0
4.	Over all Mean	20.4	50.7

7.3. Constraints in adoption:

Survey of 37 farmers revealed four major constraints in adoption of rodent management technologies. Majority of farmers (35%) opined that despite rodent damage to crops, use of rodenticidal baits is avoided due to social reasons. Lack of awareness was the constraint for only 11% farmers. Interestingly 24% farmers said that rodents are not the problem in their fields because of hard soils. However during study, these fields also experienced damage from immigrating rodents. Rodents being highly secretive and mobile, many times farmers are not able to perceive the problem. Therefore this may also be considered as lack of awareness among farmers. More than one fifth (21%) farmers opined that non-availability of quality rodenticides is a constraint in effective adoption of technology.