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# RODENT PESTS IN SOME CROPS OF GUJARAT

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## INTRODUCTION

It is well established that by virtue of extremely adaptable nature, highly intelligent pattern of behaviour and tremendous potential to multiply, rodents maintain large population which cause considerable damage to crops in all stages of production and storage. However, intensity of damage differ according to rodent species, from crop to crop and from one ecological niche to another. Thus, for the formulation of an integrated control measure, it is necessary to study the rodent species composition, rodent population, intensity of damage, and crop pattern of the different ecological regions. Except the reports of BNHS Mammal Survey (1912-14) Madsen (1975), Shah (1979), Jhala *et al.* (1990), Mittal *et al.* (1991), and Rodent control measures undertaken in Gujarat (Anon, 1990, 91), we have very little knowledge about the rodent species, their population, and relationship with the agricultural crops of Gujarat.

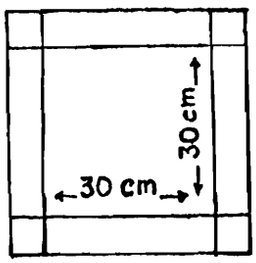
FAO of the united Nations reports that in the warmer regions of the world there are three rats per human inhabitant (Anon, 1975). Another report mentions that India's rodent population is as great as six times than that of humans (Anon, 1974). The impact of such population which is largely dependent on food grains is alarming. Recent estimates of India's food grain loss due to rodents are in millions of tons, at a cost of hundreds of millions of rupees (Srivastava 1968, Patnaik 1969). Such estimates are quite speculative, but the number of rodents and the extent of damage are indeed great. On the other hand, several field studies clearly showed that the cost-benefit ratio in rodent control operations in India ranges from 1 : 75 to 1 : 100 (Prakash 1976). Gujarat produces chief cash crops of India which also earns foreign exchange. Thus, an attempt has been made to fill up the lacunae between crop production and loss due to rodent menace.

## STUDY AREA

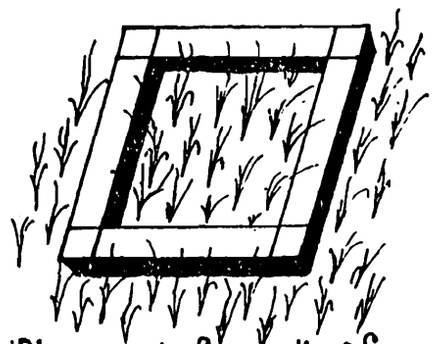
Gujarat, the western most state of India is bounded by Pakistan and Rajasthan at the north, Arabian Sea at the west and south and Madhya Pradesh and Maharashtra at the east. Politically it is divisible into nineteen districts of which Jamnagar, Rajkot, Surendranagar, Junagadh, Amreli, Bhavnagar, Dangs, Surat, Varuch, Vadodara were surveyed from 1990-1992.

## MATERIAL AND METHODS

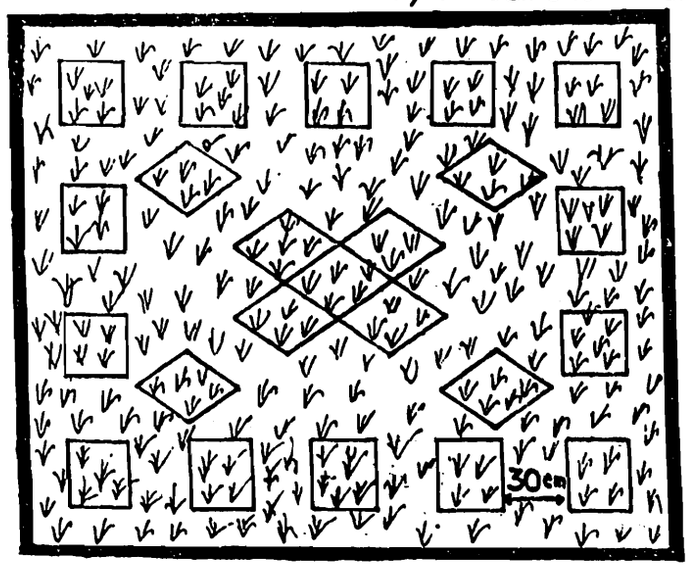
The present investigation was carried out in the crop fields, weed fields, barren lands and also in the godowns, residential areas and orchards. Systematic trappings




a) Sampling frame



b) Placement of sampling frame




c) Positions of sampling frames in a plot

FIG. 1

were conducted with Shermon, Break-back and wonder traps to find out the species composition. Yield loss has been expressed in terms of percent crop damage with a slight modification of the method of Posamentier and van Elsen (1984). Aluminium frames were selected for that, each frame covering an area of 2500 sq. cm., placed diagonally and peripherally (Fig. 1) at a distance of 30 cm in the selected fields. The plants in the squares were marked with small aluminium pieces. The damaged plants among the marked plants were counted from time to time at seedling, immature and mature stages. The aluminium frames can be disarticulated easily for carrying and resetting. Data based on at least 25 sample fields per taluka were compared and statistically analysed. The formula applied $D\% = 100 \times B/A$ where D% denotes percentage of damage, 'A' denotes number of plants counted, 'B' denotes total number of plants damaged.

Table 1. Rodent pests recorded from Gujarat and their Pest Status

| Common Name | Scientific Name | Pest Status |
|---|---|---|
| Indian Antelope Rat | *Tatera indica* Hardwicke | + + + |
| Indian Desert Gerbil | *Meriones hurrianae* (Jerdon) | + + |
| Hairy footed Gerbil | *Gerbillus gleadowi* (Murray) | + |
| Common Indian Rat | *Rattus rattus* Linn. | + + + |
| Cutch Rock Rat | *Cremnomys cutchicus* (Wroughton) | + |
| House Mouse | *Mus musculus* Linnaeus | + + + |
| Indian Field Mouse | *Mus booduga* (Gray) | + |
| | *Mus dunni* Wroughton | + |
| | *Mus cervicolor* Hodgson | + |
| Brown spiny Mouse | *Mus platythrix* Bennett | + |
| Soft furred Metad | *Millardia meltada* (Gray) | + + |
| Lesser Bandicoot Rat | *Bandicota bengalensis* Gray | + + + |
| Large Bandicoot Rat | *Bandicota indica* (Bechstein) | + |
| Indian Bush Rat | *Golunda ellioti* (Gray) | + |
| Indian Crested Porcupine | *Hystrix indica* | + |
| Five striped Palm Squirrel | *Funambulus pennanti* Wroughton | + |

+ + + Very serious and widespread
+ + Serious
+ Not so serious

## RODENT SPECIES RECORDED

**Tatera indica** Hardwicke
The Indian Antelope Rat

Colour sandy brown, reddish dorsally and offwhite ventrally ; eyes large ; round ears with white patch above and behind the eyes and a spot behind the ears ; feet whitish, soles of hind foot naked and pale in colour ; tail darker with a pencil of black hairs. TL longer than HB which may ranges up to 187 mm. Mammae 8, BW 100-250 g (♂) and 70-200 g (♀).

*Distribution* : From Syria through Turkestan, Iraq, Iran, northern Saudi Arabia, Afganisthan, Baluchistan to India and Sri Lanka.

*Present records* : Crop fields, weeds and barren lands, godowns, residential areas and orchards.

**Meriones hurrianae** (Jerdon)
The Indian Desert Gerbil

Dark sandy grey or brownish grey above, offwhite below ; feet whitish or light brown, soles partly haired. HB 106-143 mm, TL 100-164 mm, Hf 27-28 mm, E 8-12 mm, Mammae 8, BW 40-160 g.

*Distribution* : Southern Afganisthan, SE Iran. Pakistan and Western India.

*Present records* : Crop fields, weeds and barren lands.

**Rattus rattus** Linnaeus
Common Indian Rat

Dorsal parts with various shades of grey, ventrally paler, long tail obviously

HB — Head and Body
BW — Body weight
Hf — Hind foot.
E — Ear.

more than HB length, body slender and snout pointed. Mammae usually 2+3=10 or 3+3=12.

*Distribution* : Throughout the world as a human commensal.

*Present records* : Crop fields, godowns, residential areas and orchards.

**Cremnomys cutchicus** (Wroughton)
Cutch Rock Rat

Dorsally greyish and ventrally paler, HB 105-149 mm ; tail normally longer than HB and fairly well haired ; hind foot appears somewhat arboreal; mammae 1+2=6.

*Distribution* : Peninsular India, Maharashtra and Gujarat.

*Present records* : Forested areas, weed fields, barren lands, and cotton cultivation.

**Mus musculus**
House Mouse

A small greyish mouse, HB 65-95 mm, TL 60-105 mm but generally longer than HB. BW 12-30 g.

*Distribution* : Perhaps naturally from the Mediterranean region to China, now found partly as a human commensal throughout the world.

*Present records* : Godowns, crop fields and residential areas.

**Mus booduga** (Gray)
Indian Field Mouse

Tiny grey field mouse, HB 80 mm ; slender, short, naked and bicolour tail, measuring 40-80 mm, BW $\pm$10 g.

*Distribution* : India, Sri Lanka and Mayanamar.

*Present record* : Cultivation.

**Mus dunni** Wroughton

Sympatric species of *M. booduga*, only differs by having an extra cusp on the anterior lamina of first upper molar ; undersurface of body grey. HB ± 77 mm, TL ± 55 mm, Hf ± 14·5 mm and E ± 12 mm.

*Distribution* : India : West Bengal (Bankura dist.), Bihar, Gujarat, Orissa, Karnataka, Maharashtra and Uttar Pradesh.

*Present records* : Cultivation, weeds and barren lands.

**Mus cervicolor** Hodgson

Fawn coloured medium sized mouse, HB ± 70 mm, TL ± 65 mm and definitely shorter than HB length ; BW 10-15 g.

*Distribution* : Found partly as a human commensal from Nepal to Manipur and Southern India. Perhaps introduced to Indochina, Sumatra and Java.

*Present records* : Crop fields, godowns, residential areas, orchards, weeds and barren lands.

**Mus platythrix** Bennett
Brown Spiny Mouse

Colour brownish, HB 100 mm approx. ; TL 90 mm approx. ; hairs are crisp and usually tend to be spiny.

*Distribution* : India.

*Present records* : Crop fields, weeds and barren lands.

**Millardia meltada** (Gray)
Soft-furred Field Rat

Fur soft, upper parts sandy grey, greyish brown or whitish buff lined with

brown ; underparts whitish or greyish ; tail dark above and light below. HB 80-200 mm, TL 68-186 mm, BW 70 g.

*Distribution* : Pakistan, India, Nepal and Sri Lanka.

*Present records* : Crop fields, weeds (in fodder growing fields).

**Gerbillus gleadowi** (Murray)
Hairy footed Gerbil

Slender, sandy buff gerbil. sides and flanks paler ; underparts pale sandy grey or whitish. Tail longer than head and body, moderately well furred, proximal end darker and distal end darkest, underside lighter, fairly long ears ; hind foot very long, usually over 25 percent of the head and body length, claws fairly long and soles hairy. HB 50-130 mm, TL 70-150 mm, BW 20-40 g.

*Distribution* : Pakistan and western India.

*Present records* : Weeds and barren lands.

**Golunda ellioti** (Gray)
Indian Bush Rat

Fur may be coarse and slender with fine spiny hairs or sometimes fairly soft with only a few harsh hairs. Coat generally thin but the hairs rather long. Upperparts greyish, yellowish brown, reddish brown or fairly dark brown ; underparts light grey, bluish grey or white. Head short and rounded ; ears rounded and hairy ; tail shorter than head and body and stout at the base, tapers towards the tip and covered with coarse short hairs. HB 110-115 mm, TL 90-130 mm, BW 50-80 g, Mammae 8.

*Distribution* : Pakistan, India, Nepal, Bhutan and Sri Lanka.

*Present records* : Weed fields, Barren lands and crop fields.

**Bandicota bengalensis** (Gray)
Lesser Bandicoot rat

Dark greyish brown speckled with buff, underside paler ; tail wholly dark, feet dark, digits paler. Robust build with rounded head and ears ; short and broad muzzle. Fur coarse, sometimes with long blacktipped piles throughout the upper surface. HB 132-266 mm, TL 130-180 mm, shorter than head and body. Mammae 12-18.

*Distribution*: From Pakistan to Mayanmar, Sri Lanka, Penang Island off west coast of Malay Peninsula, Sumatra and Java.

*Present records* : Crop fields, weeds and barren lands, godowns, residential areas and orchards.

**Bandicota indica** (Bechstein)
Large Bandicoot Rat

Very large rat, dorsum blackish or blackish brown, underparts grey, drab or dark. Tail usually shorter than head and body, naked with certain growth of short hairs throughout its length. Fur harsh, with plenty of long hairs on the back ; ears rounded, limbs very powerful ; mammae 12. HB 200-366 mm, TL 130-258 mm, BW 500-1000 g but may reach up to 1,500 g (Grzimek, 1975).

*Distribution* : From Rajasthan south and east to almost throughout India ; Bangladesh of SE. Asia.

*Present records* : Residential areas and godowns.

**Funambulus pennanti** Wroughton
Five-striped Palm Squirrel

A medium sized rodent with bushy tail which may be equal to head and body length. Dorsum brownish grey with five whitish stripe separated by four off white bands. Three middle stripes longer than the two lateral ones. Colour of the tail basally white with a blackish mid portion and whitish tip. Ears small and covered with soft fur. HB 115-178 mm.

*Distribution* : India, Pakistan and Nepal.

*Present records* : Orchards, residential areas, sugarcane and groundnut cultivation.

**Hystrix indica** Kerr
Indian Porcupine

Hairs modified more or less completely into spines ; neck and shoulders crowned with a crest of bristles about 15-30 cm long ; quills on the back very profuse and ornamented with dark brown or black and white rings ; large white rattling quills on the tail. HB 700 900 mm, TL 80-100 mm, BW 11-18 kg.

*Distribution* : From India, westwards through Persia and Baluchistan to Syria, Asia minor and Palestine.

*Present records* : Restricted to the crop fields near forested areas.

Table 2. Rodent species recorded from different crop fields

| | |
|---|---|
| **Bajri & Jowar** | *Tatera indica, Bandicota bengalensis, Mus booduga.* |
| **Maize** | *Bandicota bengalensis, Millardia meltada, Tatera indica.* |
| **Wheat** | *Bandicota bengalensis, Millardia meltada, Tatera indica, Mus musculus, Mus booduga.* |
| **Pulses** | *Tatera indica, Bandicota bengalensis, Meriones hurrianae, Millardia meltada, Rattus rattus, Mus dunni, Mus musculus, Mus booduga.* |
| **Rice** | *Bandicota bengalensis, Tatera indica, Millardia meltada, Mus platythrix, Mus dunni, Mus musculus, Mus booduga, Mus cervicolor.* |
| **Cotton** | *Bandicota bengalensis, Tatera indica, Millardia meltada, Mus platythrix, Mus dunni, Mus musculus, Mus boodugo, Mus cervicolor, Cremnomys cutchicus.* |
| **Sugarcane** | *Bandicota bengalensis, Tatera indica, Golunda ellioti, Millardia meltada, Mus booduga, Mus platythrix, Funambulus pennanti, Hystrix indica.* |

| | |
|---|---|
| Groundnut | *Tatera indica*, *Bandicota bengalensis*, *Millardia meltada*, *Meriones hurrianae*, *Mus platythrix*, *Mus musculus*, *Mus cervicolor*, *Funambulus pennanti*, *Hystrix indica.* |
| Orchards | *Funambulus pennanti*, *Rattus rattus*, *Bandicota bengalensis.* |
| Vegetable Cultivation | *Bandicota bengalensis*, *Millardia meltada*, *Golunda ellioti*, *Rattus rattus*, *Hystrix indica.* |
| Chillie Cultivation | *Meriones hurrianae*, *Tatera indica*, *Mus booduga*, *Bandicota bengalensis.* |

Table 3. Percentage of rodent species recorded from residential areas and godowns

| | |
|---|---|
| *Rattus rattus* | 49 |
| *Mus musculus* | 32 |
| *Bandicota bengalensis*, *Bandicota indica*, *Tatera indiea*, *Funambulus pennanti*, *Mus cervicolor* | 19 |

Table 3A. Percentage of rodent species recorded from weed fields and barren lands

| | |
|---|---|
| *Gerbillus gleadowi* | 18 7 |
| *Tatera indica* | 43·0 |
| *Meriones hurrianae* | 19·3 |
| *Golunda ellioti* | 4·5 |
| *Bandicota bengalensis* | 7·0 |
| *Mus dunni*, *Mus cervicolor*, *Mus platythrix* | 4·6 |
| *Millardia meltada* (only in fodder growing fields) | 2·1 |
| *Cremnomys cutchicus* | 0·8 |

Table 4. Percent damage of different crops

| | Seedling | Flowering | Fruits (Immature) | Fruits (Mature) |
|---|---|---|---|---|
| Rice (*Oryza sativa*) | 0·2 | 1·3 | 10·7 | 30·2 |
| Bajri (*Pennisetum typhoides*) | — | 2·7 | 8·3 | 34·3 |
| Jowar (*Andropogan sorghum*) | 0·7 | — | 3·8 | 27·8 |
| Wheat (*Triticum aestivum*) | 0·8 | 1·8 | 11·2 | 31·8 u |
| Maize (*Zea mays*) | — | 1·2 | 14·3 | 30·0 |
| Sugarcane (*Saccharum officinarum*) | 2·8 | — | 8·7 | 20·1 |
| Groundnut (*Arachis hypogaea*) | 4·5 | — | 2·8 | 42·7 |
| Cotton (*Gossypium* sp.) | — | — | 23·3 | 18·2 |
| Chilly (*Capsicum frutescens*) | 0·0 | — | 1·1 | 15·0 |
| Potato (*Solanum tuberosum*) | 7·2 | — | 2·2 | 27·5 |
| Sweet Potato (*Ipomoea batatas*) | — | — | 2·9 | 28·3 |
| Tomato (*Lycopersicon esculentnm*) | 0·3 | 1·8 | — | 28·7 |
| Banana (*Musa* sp.) | 3·2 | — | — | 27·7 |
| Papaya (*Carica papaya*) | — | — | — | 19 3 |
| Watermelon (*Citrullus vulgaris*) | 0·3 | — | 8·5 | 27·6 |

It is well known that rodents damage standing crops both 'kharif' and 'rabi', almost at every stage of their vegetative growth and at the same time also cause damage in the godowns. The chief food crops of Gujarat are bajri, jowar, wheat, maize, rice, pulses, etc. and main cash crops are sugarcane, groundnut and cotton. Among the vegetables, potato, chilly, sweet-potato, onion, tomato, cabbage, carrot are the main products and mango, banana, papaya, watermelon are the main fruits. There are three main crop seasons in Gujarat i.e., 'kharif', 'rabi' and summer. 'Kharif' crops receive about 95% of monsoon rain and other crops usually depend on irrigation. Among the sixteen species of rodent pests recorded from Gujarat, it has been observed that *Tatera indica* is most predominant in the drier region and *Meriones hurrianae* appears to be more in purely sandy zone. *Bandicota bengalensis*, *Millardia meltada* and *Tatera indica* cause maximum damage to the crops and *Funambulus pennanti* in the gardens and orchards. *Rattus rattus* and *Mus musculus* cause maximum nuisance in the godowns and residences. Rodent species composition and population varies greatly according to the crop. Rodent species composition in major crop fields is stated below :

## A. Food Crops

### a. cereals

#### (i) *Millet*

*T. indica* is the predominant species in bajri and jowar fields followed by *B. bengalensis* and *M. booduga* whereas *B. bengalensis* is most abundant in maize cultivation followed by *M meltada* and *T indica* (Table 2). In seedling stage percent plant damage by rodents was only 0·7 in jowar. The same in seedlings of bajri and maize was not recorded. When the plants were with bloom, it was slightly higher i.e, 2·7 in bajri and 1·2 in maize and while the plants were with milky seeds or immature fruits a sharp rise of percent plant damage was observed up to 14·3 in maize but in bajri and jowar it was only 8·3 and 3·8 respectively and it was always high in mature plants as 34·3, 27·8 and 30·00 in bajri, jowar and maize respectively (Table 4).

It was noted that percent damage of mature tillers deviate highly from one crop field to another and also from one year to another. It also depends on the position of the crop fields. If the cultivation is adjacent to weeds and barren lands then the rodent damage was comparatively higher as the rodents used to come from the adjacent fields temporarily for feeding only. As the kharif maize is grown for grain purpose and rabi for green cobs, so percent damage in kharif crop is higher than rabi. So the total yield loss due to rodent menace in millet may reach up to $\pm$ 41·03 percent.

(ii) *Wheat*

Severe rodent damage to wheat has already been reported in the districts Amreli, Bhavnagar, Junagadh and Rajkot and medium damage has been reported in Ahmedabad and Gandhinagar districts (Anon, 1990). It was observed that *B. bengalensis* is the most predominant rodent pest in the wheat cultivation followed by *Millardia meltada* and *T. indica* (Table 2). In seedling stage, average plant damage was only 0·8 percent and it was slightly higher i.e., 1·8 percent in blooming plants. As soon as milky seeds appeared, a sharp rise of plant damage from 1·8 to 11·2 percent was observed. Maximum damage was estimated to be 31·8 percent as the wheat was harvested and thus total yield loss may reach up to ± 46·6 percent (Table 4). Rodent menace was maximum in the Junagadh and Amreli districts particularly in the forest side cultivation. In those districts *M. musculus* and *M. booduga* were also collected from the wheat fields but no burrow system was observed.

(iii) *Rice*

Rice is chiefly a kharif crop and fourth major cereal crop of the state. Maximum damage to rice is caused by *B. bengalensis* followed by *T indica*, *M. meltada*, *M. booduga*, *M. platythrix* and *M. cervicolor* (Table 2). Rodent damage to rice starts from sowing when water level is low for germination of seed and continued till it ripes. During sowing the sprouted seeds are consumed by rodents. In seedling stage rodent damage was observed only in 0·2 percent plants. In the flowering plants and in the plants with milky seeds it was 1·3 and 10·7 percent respectively. But when the seeds ripen, a sharp rise of percent damage from 10·7 to 30 2 percent was observed causing a total yield loss of ± 42·4 percent (Table 4).

The damage assessment of cereals is far from satisfactory as the rodents damage a lot when the cereals are ready for harvesting and in godown also. Sridhara (1992) stated that 'damage concentrated in the centre of the field is indication of heavy rodent attack'. But it was noticed that in heavily damaged fields also, the rodents damage not only concentrated in the centre but also scattered throughout the field even in case of roadside and bundh side fields where damage in the centre is very common. It may be due to community cultivation as stated by Lavoi *et al.* (1970). It was also noticed that like other cereals rodent species diversity in the rice fields by the side of barren lands and weed fields is much higher than the other. The burrow systems of all recorded rodent species were not observed in the rice fields. Burrows of some rodents which were observed in the weed fields and barren lands were captured from the crop fields at night.

*Hoarding of Cereals* :

Hoarding habit of bandicoots is well known and reported by many (Sridhara, 1992)

in respect of rice. Among the bandicoots *B. bengalensis* hoards maximum, the average hoarding of rice is 2·67 kg/burrow, bajri 2·53 kg/burrow and jowar only 1·27 kg/burrow. Hoarding of kharif maize by *B. bangalensis* was observed only in the burrows of bundhs but not measured, and that of rabi maize was not observed though it damages both *kharif* and *rabi* maize in the field in every stage of its growth. It was mentioned earlier that rabi maize is grown mainly for green cobs where seeds are not fully ripened. It may appear, therefore, that *B. bengalensis* does not store the milky seeds.

b. Pulses

Among the pulses Mung, Moth, Black gram, Gram, Horse Gram, Lang or Chickling vetech, Val or Indian bean and Tuver or Pigeon per-tur are usually cultivated. From pulse cultivation *T. indica*, *B. bengalensis*, *M. hurrianae*, *M. meltada*, *R. rattus*, *M. dunni*, *M. musculus*, *M. booduga* were collected (Table 2). Percent plant damage was not estimated as the variety of pulse was different in different districts even in different talukas but overall *T. indica* was most predominant in western districts and *B. bengalensis* in southern and eastern districts. Population density varies much from one field to another and also differs according to the species but high population density of rodents were always observed when the pulses were ready for harvesting. Altogether 43 rodents were captured from the pulse field : *T indica* 15, *B. bengalensis* 14, *M. hurrianae* 5, *Millardia meltada* 3, *R. rattus* 1, *M. dunni* 2, *M. musculus* 2, and *M. booduga* 1 in number.

c. Vegetables

Vegetables like potato, sweet potato, tomato, onion, gourd, pea, cabbage, carrot and brinjals are usually cultivated in Gujarat of which plant damage was only estimated in potato, sweet potato and tomato fields. Percent plant damage was high at the time of sowing in tubers i.e., 7·2 in potato and the same is rather less in tomato i.e., 0·3 in seedling stage. At the time of sowing the rodents used to dig the field and take out the seed tubers for consumption. Percent damage in immature plants was rather less i.e., 2·2, 2·9 and 1·8 in potato, sweet potato and tomato respectively, but there was also a sharp rise in percent plant damage in matured plants i.e., 27·5, 28·3 and 28·7 in potato, sweet potato and tomato respectively (Table 4). It was observed that in tomato cultivation where *telephone* system (tying of a single row of plant with a single wire) was applied, crop damage by rodents was rather less. It was also observed that the rodents never consume more than 30 percent of any vegetable. In vegetable gardens *B. bengalensis* was the most abundant species followed by *M. meltada*, *G. ellioti* and *R. rattus* (Table 2). *Histrix indica* was only observed in potato and sweet potato cultivation in forest side villages. Population density of the porcupine gradually increases with the crop maturity and varies greatly according to the type of crop. The total yield loss calculated was $\pm$ 32·96 percent.

Chilly is the chief spice cultivated in Gujarat. The rodents captured from chilly cultivation were *M. hurrianae* and *T. indica* (Table 2). *B. bengalensis* was captured only thrice and *M. booduga* only once. Burrows of *M. hurrianae* and *T. indica* were observed in the chilly fields but no burrow system of other species was observed. Rodents usually do not damage the seedlings and only 1·1 percent of immature plants were attacked by them. Extensive burrow systems of rodents mainly damaged the immature plants but 15 percent plants with mature chillies got damaged (Table 4) and the total yield loss was estimated to be ± 16·1 percent. Actually gerbils are very fond of chilly seeds and they caused more damage when chilly was spread out for drying.

## B. Cash Crops

Among the cash crops, cotton, sugarcane and groundnut are the three main crops cultivated in Gujarat. There has been a considerable increase in recent years in the cultivation of non-food or cash crops mainly tobacco and cotton along with edible sugarcane and groundnut.

### *Cotton*

Gujarat is one of the chief cotton producing states of India for its black cotton soil and favourable atmosphere for cotton cultivation. Usually three types of cotton are cultivated i.e., closed ball or *dhollera*, *mathio* and American cotton *deviraj* or Co-2-170. It is usually sown in June-July, begins to flower by the end of November and picking of seeds starts by the end of February and lasts up to mid April.

It was observed that rodent damage in seedling stage was minimum. Maximum damage was caused by the rodents to the buds and flowers of the plants. As the rodents usually do not damage the whole plant, so the same plant bears both damaged and undamaged buds. The buds which are present near the soil are damaged more than the upper ones. Percent damage calculated in flowering or immature plants was 23·3 but percent damage in matured seed cotton was not more than 18·2 (Table 4). Thus, the total yield loss may reach up to ± 41·5. Severe rodent damage to cotton was observed in Rajkot, Jamnagar, Junagadh, Amreli, Varuch and Vadodara districts and medium damage in the districts Surendranagar and Bhavnagar. But in earlier years severe damage was reported from Bhavnagar and medium damage in Gandhinagar district (Anon, 1990).

In the cotton cultivation, *B. bengalensis* is the most predominant species followed by *T. indica* and *M. meltada*. The other species recorded are *M. platythrix*, *M. dunni*, *M. musculus*, *M. booduga* and *C. cutchicus* (table 2). *B. bengalensis* and *T. indica* also

damage the roots of the plants resulting in death or ill-health. Though *G. ellioti* was not captured in the cultivation yet damage of cotton buds by them was reported by farmers.

Cotton is normally grown by rotation with other crops. In Gujarat, it is usually rotated with jowar, bajri and sesamum. It was noted that though species composition is not same in the cotton and rotating crops yet the major pests are same in both i.e. *B. bengalensis* and *T indica.* It is splendid enough though major pests are very fond of buds and flowers yet minor pests mainly *Mus* relish capsules.

*Sugarcane*

Sugarcane is an important cash crop of Gujarat which is sown in February and harvested by December-January. It was observed that the most abundant rodent species in sugarcane field is *B. bengalensis* followed by *M. meltaaa, G. ellioti, T. indica, M. booduga, M. platythrix* and *F. pennanti* (Table 2). *Hystrix indica* was also seen in the sugarcane cultivation near forest area at moonlit night. Sithanantham (1986) has also reported *H. indica* from sugarcane field.

Though eight species of rodents were recorded from sugarcane cultivation yet *B. bengalensis* can only be stated as a pest. Srivastava (1992) also stated that "despite frequent attacks, rats have been rated as occasional pest in sugarcane with low potential for damage and generally posing no serious problem" whereas many scientists stated rodents as serious pest of sugarcane (Bates 1967, Bhutani & Bhatnagar 1978, Kalra 1979, Gupta *et al* 1982, Prakash & Avasthy 1980, Avasthy & Prakash, 83, Ahmad & Parshad 1985, Parshad 1987).

It was observed that population of *B. bengalensis* in sugarcane field in southern and eastern districts of the state was very high, about 78 percent, whereas that in western districts was rather low and replaced by *T. indica.* Population of *T. indica* in southern and eastern districts was only 3 percent whereas about 32 percent in northern and western districts. Thus, it can be stated that population of *T. indica* was comparatively high in the drier zone than the wet areas.

Rodents are frequent in this crop right from the seedling stage but their population density increases proportionately with the development of the crop reaching a peak during crop maturity as has also been observed by Srivastava (1992) in Uttar Pradesh. Burrows of *B. bengalensis* and *M. booduga* were frequent in the sugarcane fields but other rodents usually migrate from the fringes to the crop fields.

*B. bengalensis* damages the plants by making extensive burrows and consumes the roots also. It usully damages first and second internode from the ground and rarely upper ones. Srivastava (1992) also stated that it damages first one or two

intetnodes resulting cane death but after lodging 1—5 internodes are eaten out. *Mus* sp. are usually seen to lodge in the cane cavity. Rodents damage this crop from the seedling stage and percent damage was 2·8 which was rather higher than cereals. Apical buds and growing tissues were also taken by rodents. Damage of immature plants (up to 120 cm) was estimated to be 8.7 percent and the same was more than double in sweet juicy matured plants and estimated as 20·1 percent (Table 4) causing a total yield loss of ± 31·6 percent. But in fact, this assessment in case of sugarcane may have errors as it is very difficult to enter a sugarcane field and to locate the damaged plants when sugarcane is fully grown.

Sugarcane is simultaneously affected by fungi, insects and rodents so it is rather difficult to identify rat damage from the drying crown and leaves as stated earlier (Srivastava, 1992) but lodging of clumps and heaps of soil around clumps and boat shaped cavities are prominent sign of rodent damage.

*Groundnut*

Rodents are serious pests of groundnut in Gujarat and effect much on state economy. Though attempts have been made by many *viz* , Mittal and Vyas (1992), Mittal *et al.* (1991), Patel and Nayak (1987), Shah (1979), Shihari *et al.* (1979) to assess species composition' relative abundance, and yield loss by rodents in groundnut yet many more informations are required to check rodent menace. *Kharif* groundnut is sown in June—July and harvested in October. Rodents affect groundnut fields from sowing to harvesting. As soon as the seeds were sown, the rodents damage the pods by eating the same. At that time no hoarding was observed in the rodent's burrow. It was observed that 4·5 percent germinating plants or seedlings were damaged by rodents which decreases to 2·8 percent during August and sharp rise up to 42·7 percent at the time of harvesting (Table 4). Though 42·7 percent plants were affected by rodents yet all the pods of a plant were not damaged. Percent pod damage may vary from 5 to 73 in respect of individual plants.

*B. bengalensis* is probably the most important rodent pest in groundnut followed by *T. indica* and *M. meltada*. Beside these *M. hurrianae*, *M. platythrix* and *M. musculus* were also trapped from the fields. *H. indica* was only seen twice in the forestside fields. Ratio of population among *B. bengalensis*, *T. indica* and *M. meltada* in the drier western district was 40 : 40 : 20, but that in the wetter southern and eastern districts was 70 : 10 : 20. Only *M. meltada* maintain an approximate stable population.

Farmers do not want to disturb the crop fields after peg formation which encourage the rodents for invading the field and to make extensive burrow system. Where there was less rainfall rodents made burrow under the shades of the plants and while the rainfall was much they made burrows at the bundhs, In the bundhs burrows of *B. bengalensis*

have only be seen with a few negligible exception. In case of heavy rainfall area rodents usually take shelter in nearby weed fields and barren lands. Burrows of *T. indica* was very common in the barren lands near groundnut cultivation. *B. bengalensis* did not hoards pods in the month of August / September, that may be due to immaturity or heavy rainfall. The population of rodents was maximum at the time of harvesting. At thnt time groundnut pods were hoarded to the extent of 485 gm/burrow but earlier it was recorded as 320 gm/burrow (Patel & Nayak, 1987). Yield loss was much higher in the isolated fields than cooperative farmings because *Kharif* groundnut cultivation used to affect much by visiting rodents from the adjacent barren lands and weed fields than residential ones. Mittal and Vyas (1992) also reported that "extent of yield loss in one isolated field surrounded by Barren/fallow was as much as 85·42 percent during summer."

In Gujarat state loss due to damage by rodents in groundnut was estimated to be to the tune of Rs. 243, Rs. 815 and Rs. 669/ha during the year 1988, '89 and '90 respectively (Mittal & Vyas, 1992). But in the present study only plant damage was estimated and it was thought that assessment of yield loss will be rather speculative as most of the plants were partly damaged and the damaged mature plants were always with undamaged mature pods.

### C. Orchard

Area under fruits is not extensive in the state. The main fruits grown are mango, papaya, banana, watermelon and grape cultivation has recently been started. Among the rodents *F. pennanti* causes maximum damage to the orchards. Other than five-striped palm squirrel, *R. rattus* and *B. bengalensis* also invade in the orchards. But it is rather difficult to estimate the loss caused by rodents as non-rodents species like aves and chiropterans cause maximum damage. It was observed that forestside orchards are usually more affected by both rodent and non-rodent species than other areas. *H. indica* was seen in the watermelon cultivation only on two occasions.

## SPECIES COMPOSITION IN THE WEED-FIELDS, BARREN LAND AND GODOWNS

Rodent species composition was rather high in the weed field and barren lands. Among the rodent species recorded from the weed fields and barren land *T Indica* (43·0%) was the most predominant one followed by *M. hurrianae* (19·3%), *G. gleadowi* (18·7%), *B. bengalensis* (7·0%), *G. ellioti* (4·5%), and *M, dunni*, *M. cervicolor*,

*M. platythrix* comprised only 4·6 percent. *M. meltada* was only recorded from the fodder grass growing fields and *C. cutchicus* (0·8%) comprised even less than one percent (Table 3A).

In the godowns and residential areas percent population of *R. rattus* was about 49 followed by *M. musculus* (32). Other rodent species comprised only 19 percent, which are *B. bengalensis*, *B. indica*, *T. indica*, *F. pennanti* and *M. cervicolor* (Table 3).

## DISCUSSION

From the above study it is revealed that though most of the rodents are responsible for agricultural damage yet all the rodents cannot be stated as pest. Ten rodent species are usually considered as serious pest to agriculture (Prakash, 1976) but it was noticed that *B. indica* is not so serious pest in the agriculture of Gujarat while Chakraborty (1992) considered it as an agricultural pest in West Bengal. Prakash (1976) also stated *H. indica* as a pest but in Gujarat it was seen active only in the forestside crop lands and can be treated only as pest of tubers, melons, etc. Prakash (1976) stated *M. hurrianae*, *T. indica* and *M. meltada are* the predominant rodent species in crops of Gujarat but from the present study it is revealed that *B. bengalensis* is dominating over *T. indica* and *M. hurrianae* in many places. So among sixteen species recorded from the crop fields of Gujarat only *T. Indica* and *B. bengalensis* may be stated as very serious, and wide spread pests, and *M. hurrianae* and *M. meltada* are serious best of crops (Table 1). *F. pennanti* regarded as serious pest of orchards and *R. rattus* and *M. muculus* are predominant in the residential areas and godowns (Table 1). So pest status of a species differs from place to place and also from crop to crop.

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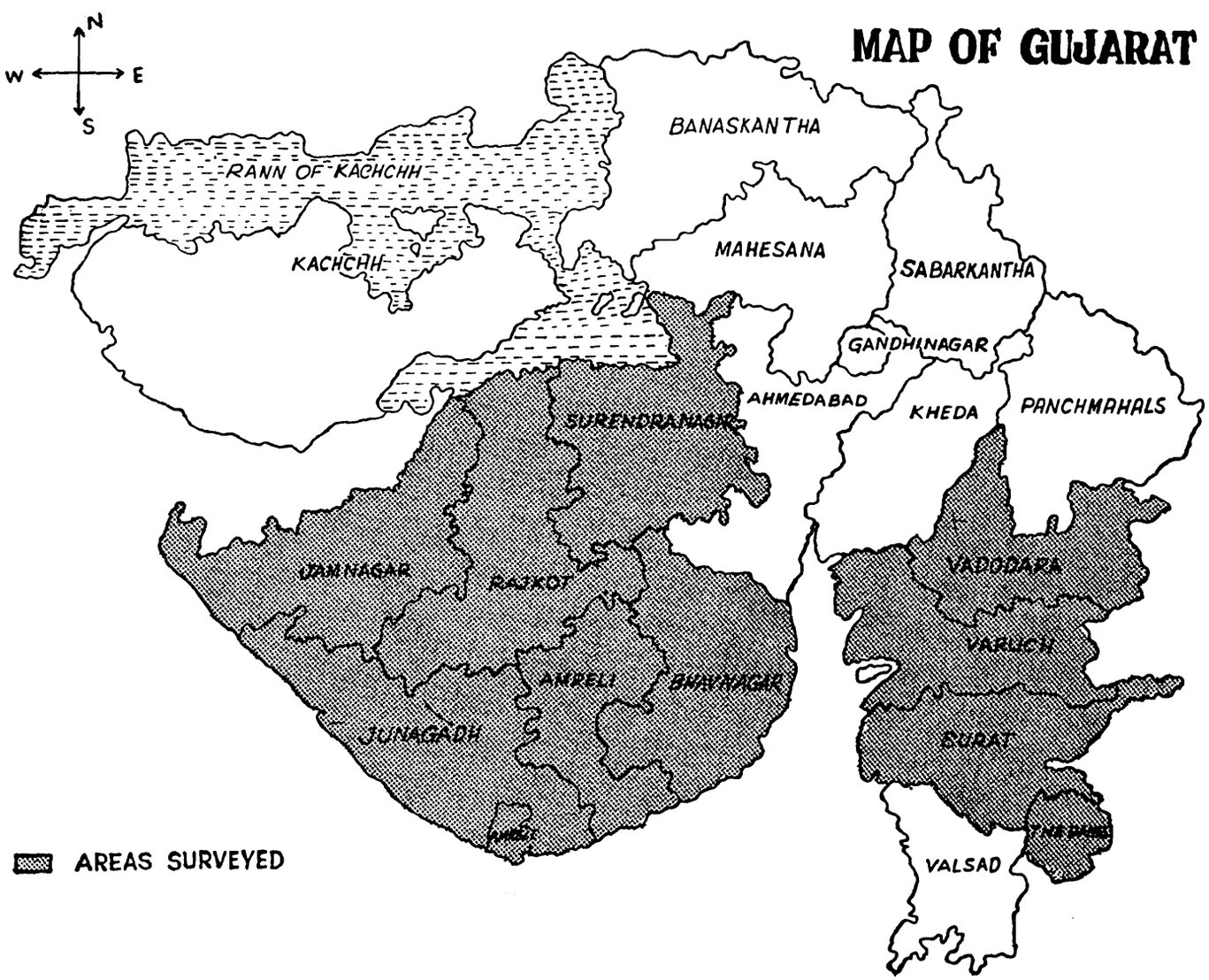
MAP OF GUJARAT
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BANASKANTHA
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KACHCHH
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SABARKANTHA
GANDHINAGAR
AHMEDABAD
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PANCHMAHALS
SURENDRANAGAR
DAMNAGAR
RAJKOT
VADODARA
VARUCH
AMRELI
BHAVNAGAR
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SURAT
VALSAD
AREAS SURVEYED