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INHIBITING RODENT DEPREDATIONS. I. DISTRIBUTION AND ABUNDANCE OF RATS AND MICE IN A WdEAT-RICE BASED CROPLAND

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This study was extended from June, 1992 through June, 1993 in a lOO-acre study block of wheat-rice based cropland near Alipur Chatta (Punjab) in which multiple-cropping was being practised. The block was found to be infested with three species of rodents viz. the lesser bandicoot rat, the soft-furred field rat, and the house mouse. The rodent populations, which generally ceased to breed during the winter season, were forced to move from one crop to another following their harvesting at different times of the year. Consequently, the pest populations dispersed and then concentrated in certain fields where they could be easily destroyed using an appropriate rodenticide. Should these concentrations in the vegetable, fodder, and sugarcane fields (which cover less than 18% of the total area of the study block) be destroyed in June and, if necessary, in October, the rodent depredations in the rice, wheat and other crops will be greatly minimized at a low cost with a little ecological disturbance.

Key words: abundance of rats and mice, control implications, wheat-rice based ecosystem

INTRODUCTION

Rats and mice have been important pests of agriculture in Pakistan since long. Several decades ago, Hussain and Pruthi (1921) from Punjab and Wagle (1927) from lower Sindh reported severe rodent damage to the food crops. Even today, throughout much of Pakistan, rats and mice exert a serious limitation on the production of a variety of crops (Greaves *et al.,* 1975; Greaves and Khan, 1975; Ahmad *et al.,* 1986; Beg *et al.,* 1977, 1978, 1979, 1988; Fulk *et al.,* 1980 a,b; Fulk and Akhtar, 1981).

For controlling rats and mice depredations in the croplands, use of toxic chemicals or rodenticides is common. Although their use is not environment friendly, yet at the present state of knowledge they seem to be the best and most effective weapons against these pests. Rodenticides must, however, be used with care in context with the behaviour and ecology of the pest species involved as well as the ecology ofthe cropland targeted for their residence. In the agrosystems, food and shelter conditions change abruptly. At times the pests have a surfeit of cover and food available to them and at other times they may be limited by these very factors. Such changes must have a profound impact on their survival, and dispersal and abundance in different crops. This paper provides information on the abundance, inter-crop movements, and distribution of rats and mice in a wheat-rice based cropland in Hafizabad district of the province of Punjab.

MATERIALS AND METHODS

This study was carried out from June, 1992 through June, 1993 on a lOO-acre block of a canal irrigated cropland situated near Alipur Chatta, District Hafizabad (Punjab). Rice and wheat were the major crops of the study block (Fig. 1) as well as of the general area around it. Fodder, vegetable and sugarcane were among the minor crops. The fodder crops consisted of the leguminoid species viz. alfalfa, clovers and the graminoid species viz. sorghum, maize and millet. Sugarcane was present in the study block only on a half-acre field. Over six acres of this block comprised the campus of the Government College, Alipur Chatta. Besides, a guava grove and a stackyard each of about halfof an acre in size were also present.

Every month from June, 1992 through June, 1993, eight acres of randomly selected fields representing all the available crops and 1.3 acres of non-crop areas viz. the stackyard, college compound and the guava grove were snap-trapped for the rodents for five consecutive nights. Fifteen traps were set in each acre of the fields under different crops. The same half-acre sugarcane field and some of the non-crop areas noted above were, however, sampled again and again during each month of the study. In each acre of the fields to be trapped, five stations were set. Each station was served with three traps, two metallic rat traps (17 cm x 9 cm) and one mouse trap (12 cm x 6 cm). Four of the five stations were located six meters deep into the fields from each of the four corners on imaginary lines joining the diagonal corners, whereas the fifth station was located near the center of the fields. The bait used was oiled wheat bread or 'roti'. The traps were set at about dusk and checked the next morning. Each specimen caught in the trap was given a field number before being brought to the

laboratory for autopsy.

During the snap trap samplings, a total of 1650 trap-nights was spent in the rice, 2175 in the wheat, 1275 in the fodder, and 1350 in the vegetable fields, whereas 975 trap nights were used in each of the following: sugarcane field, the stackyard, the college compound, and the guava grove. This resulted in the capture of 79 specimens of rats and mice from the rice, 76 from the wheat, 50 from the fodder, 88 from the vegetable, and 24 from the sugarcane fields, while 22 specimens from the guava grove, 20 from the stackyard and 3 from the college compound were caught.

The trap success (No. of animals captured ÷ No. of trap nights) x 100 was used for assessing and comparing the density of the rodent species in various crops or habitats during different months of this study. Each specimen was weighed and its body measurements were taken. The reproductive tracts of the female specimens were examined for visible embryos. In the case of the males the position of the testes (abdominal or scrotal) was noted.

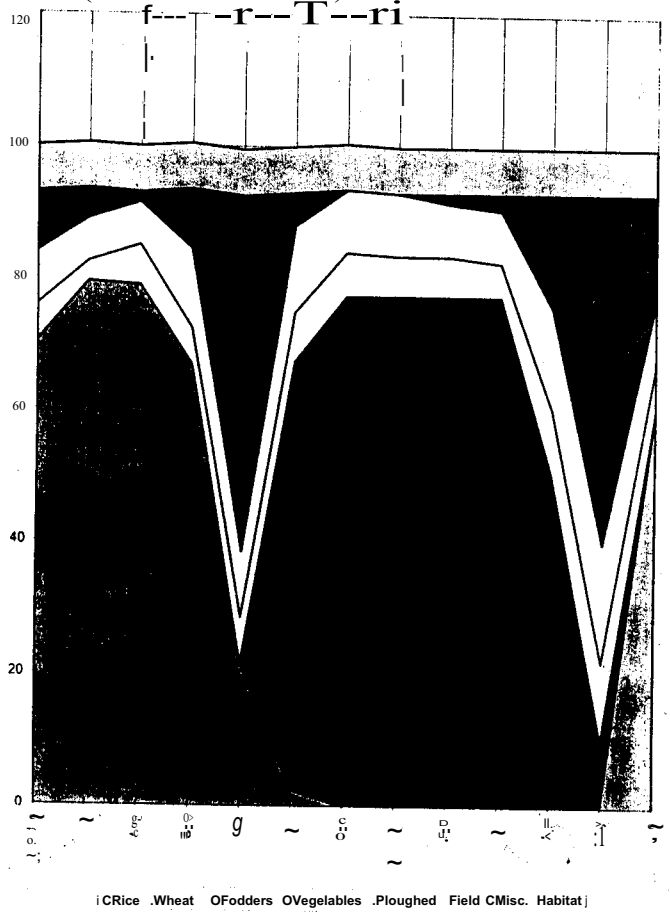

Fig. 1. Monthly variation in the vegatation cover in the study block

RESULTS

Abundance and Distribution

Rice Fields: During the period of this study transplanting of rice took place in June and early July. The crop flowered in August and matured and ripened in late September and early October and was harvested late September through early November. Rice was grown over 79% of the total area (= 100 acres) of the study block (Fig. 1). Randomly selected rice fields were sampled for rats and mice from June through November. In all, 22 acres of rice fields were sampled employing 1650 trap nights which resulted in the capture of 51 specimens of the bandicoot rat *(Bandicota bengalensis),* 13 of the house mouse *(Mus musculus)* and 15 of the soft-furred field rat *(Rattus meltada).*

The bandicoot rat was represented in all the six monthly samples. Its trap success in these monthly samples ranged from 0.3% to 7.3%, with peaks in September (6.7%) and October (7.3%), that is, mainly during the maturation and ripening phases of the rice crop (Fig. 2a). The house mouse was recorded in the September and October samples only with 3.6% and 2.2% trap success (Fig. 2b). The soft-furred field rat (hereafter field rat) affected the rice fields from August through November during which period its trap success ranged from 0.3% to 4.9%. The maximum trap success was achieved in October when only a few rice fields were left to be harvested (Fig. 2c). Thus the three rodent populations infested the rice crop in larger numbers during the maturation and ripening phases of the crop.

It is of interest to note that the abundance of the bandicoot rat in October slightly improved over that of the preceding month. A similar but stronger trend was evidenced by the field rat, whereas the house mouse population showed a decline in October. After the completion of harvesting in November, the house mouse and the bandicoot rat populations declined sharply. No such sharp decline was recorded in the population of the field rat.

The rise and fall of the rodent populations in the rice fields was seemingly influenced by a number of factors: (a) during late summer and fall all the three species maintained a high rate of reproduction (Table 1); (b) animals from other *cropsl* habitats might have been attracted to the rice fields where both food and cover was ample and the soil condition was no longer hydric; and (c) as the harvesting. of the rice crop progressed the rodents from the harvested fields might have shifted to the standing crop. The three species behaved somewhat differently to the changing food, cover and soil condition of rice fields. The

Table 1. Prevalence of pregnancy and embryonic litter size in samples of three species of murid rodents captured from study block

Season	No. of adult females	Pregnant females (%)	Litter size Mean ± S.D.
		B.bengalensis	
Winter	10	0.0(0)	-
Spring	16	62.5(10)	9.6 ± 1.91
Summer	21	47.6(10)	9.8 ± 2.01
Fall	26	57.7(15)	10.8 ± 1.76
		M.musculus	
Winter	7	14.3(1)	5.0
Spring	11	63.6(7)	6.6 ± 1.43
Summer	15	46.7(7)	6.5 ± 1.50
Fall	10	70.0(7)	7.1 ± 2.35
		Rmeltada	
Winter	3	0.0(0)	-
Spring	8	50.0(4)	5.7 ± 1.61
Summer	3	66.7(2)	5.5 ± 0.50
Fall	11	54.5(6)	6.3 ± 2.73

Table 2. Average trap success of rats and mice in various fields, cropsl subhabitats of the study block

Cropsl habitats	Trap nights	Trap success (%)(No. of animals caught) B.b.	M.m.	Rm.	Total
Rice	1650	3.09(51)	0.79(13)	0.90(15)	4.79(79)
Wheat	2175	3,45(37)	1.15(25)	0.73(16)	3,49(76)
Fodder	1275	1,73(22)	1.88(24)	0.39(5)	3.92(50)
Vegetables	1350	2,44(33)	3.41(46)	0.67(9)	6.52(88)
Sugarcane	975	1,43(14)	0.62(6)	0,41(4)	2,46(24)
Guava grove	975	0,41(4)	1.40(14)	0,41(4)	2.26(22)
Stackyard	975	1,23(12)	0.61(5)	0,03(3)	2.05(20)
College campus	975	0,21(2)	0,10(1)	-	0.31(3)
Tot/Av.	10350	1,74(180)	1,29(134)	0.54(56)	3.57(370)

B.b.=B.bengalensis, M.m.= M.musculus, Rm.=Rmeltada

bandicoot rat began infesting the rice crop in July where after attaining a high plateau -in September-October its population declined abruptly (Fig 2a). The house mouse appeared in the September and October samples only. The field rat inhabited the crop in small numbers in August and September before attaining a high peak in October past which its numbers declined but not as sharply as did those of the bandicoot rat. Perhaps the house mouse and the field rat avoided the hydric conditions that existed in the rice fields during the early growth phases ofthe crop.

Vegetable Fields: The acreage of vegetable crops varied from season to season, there being 7 to 18 acres ofthe study block under vegetable crops. During the warmer months of the year, brinjal, okra, squash and bittergourd and during the colder months, turnip and carrot were the common vegetables of the study block. The vegetable fields were sampled for the rats and mice every month from June, 1992 through June 1993. The area trapped each month varied from 1 to 2 acres. In all 17 acres of vegetable fields were sampled using 1350 trap nights which resulted in the capture of 33 specimens of the bandicoot rat, 46 of the house mouse, and 9 ofthe soft-furred field rat.

The bandicoot rats and the mice were recorded in almost all the monthly samples (Fig. 2a,b), whereas the field rat's occurrence in the vegetable fields was somewhat erratic (Fig. 2c). The trap success of the bandicoot rats varied from about 0.7% to 6.7%. The highest abundance was recorded in June and July followedby a low peak in March (Fig. 2a). The house

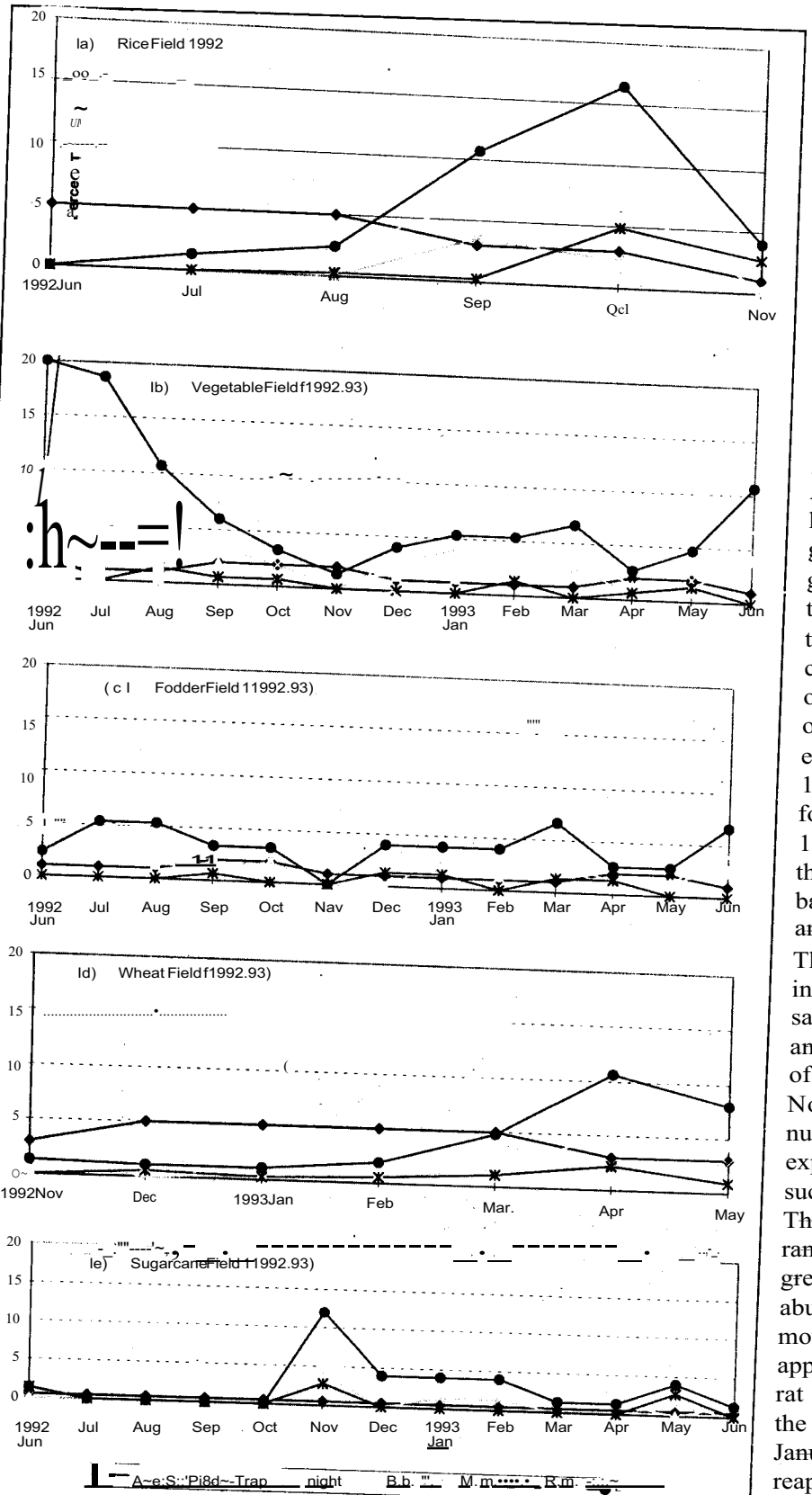

Fig. 2. Trap success and mice in various crops / subhabitats of the study block

. mice too attained peak abundance in the months of June and July, and a much lower peak in January. The range of the monthly trap success being 0.7% to 12.0%. The abundance of the field rat was relatively low as its trap success never exceeded 3% level in any of the monthly samples.

Fodder Fields: Two sets of fodder crops viz. leguminoid and graminoid were grown in the study block. Sowing of the former began in September and October and they generally remained in the fields till April. Scattered patches of clover, however, lasted till May. The graminoid fodder crops were generally sown in April and lasted till September or even later. The two types of the fodder crops jointly covered 3% to 12% of the total area of the study block. One to two acres of the fodder fields were sampled every month for the rats and mice for 13 months. A total of 16 acres of the fodder fields was sampled employing 1275 trap nights which resulted in the capture of 22 specimens of bandicoot rat, 24 of house mouse, and 5 of the field rat.

The bandicoot rats were represented in small numbers in all the monthly samples except those of ~ovember and December. After the completion of harvesting of the rice crop in November and December, larger number of the bandicoot rats was expected in the fodder fields but no such thing happened till January. The trap success of the bandicoot rat ranged from 0.7% to 5.3%, being the greatest in June (1992). The abundance pattern of the house mouse in the fodder crops approximated that of the bandicoot rat (Fig. 2b). It was not recorded in the November, December, and January samples; it began reappearing in the samples past January. The soft-furred field rat was represented in only five monthly samples and in none of these

samples its abundance exceeded 1% level of trap success (Fig. 2c).

Wheat Fields: The sowing of wheat crop in the study block began in November, that is, soon after the rice crop had been harvested. A maximum of 77.5 acres of land was cropped to wheat which closely approximated the acreage of the rice crop. The wheat crop was sampled for rats and mice for seven months from November, 1992 through May 1993. Three to five acres of wheat fields were sampled each month. Sampling of a total of 29 acres of the wheat fields involving 2175 trap nights resulted in the capture of 37 specimens of the bandicoot rat, 25 of the house mouse and 16 of the field rat.

From November through February the abundance of all the three rodents stayed low; the trap success did not exceed 0.8% in case of any of these species. In March, their abundance improved and in April they became more abundant (Fig. 2). The trap success of the bandicoot rat in April rose to 4.9%, while in case of the other two species it barely exceeded 2% level. In May, when most of the wheat fields had been harvested, the field rat became markedly less abundant, whereas the populations of the other two species evidenced little change (Fig. 2). In recently harvested fields, the house mouse utilized the sheaves of the harvested wheat plants for shelter and food. This probably enabled the mouse to maintain its numbers in the harvested wheat fields even in May. The bandicoot rat, probably on account of its grain storing habits and subterranean mode of life, was able to continue infestation of the harvested fields till May. Floodings of the fields during irrigation and subsequent ploughing had a disastrous effect on the bandicoot population. This sort of disturbance came much earlier in the rice fields since soon after being harvested they were ploughed and prepared for the sowing of wheat.

Sugarcane Fields: The cane crop is generally planted in May and June. The canes begin to sweeten by October. The crop has a protracted harvesting period which may extend from November to March depending upon the needs of the farmers and proximity to sugar mills. There was just one cane field (half of an acre in size) in the study block. It was harvested in January (1993) but was left unploughed to have a ratooned cane crop the next season.

This same cane field, which constituted 0.5% of the total area of the study block, was sampled every month from June, 1992 through May, 1993. In 975 trap nights, 14 bandicoot rats, 6 house mice, and 4 field rats were captured. During the period extending from June through October, 1992 only one specimen of the field rat was caught in June. In the November sample all the three species were represented. The bandicoot rat was represented in all the monthly samples except in that of May. It attained maximum abundance in November and December after the rice fields had been harvested. Past December its population in the canefield remained low (Fig. 2).

Non-Crop Subhabitats: The non-crop subhabitats comprising a stackyard, a guava grove, and the campus of the Government College of Alipur Chatta were trapped for 13 months. From these subhabitats 20, 22 and 3 specimens of rats and mice were recorded, respectively.

Reproduction: The samples of adult females of each of the three murid species were not sufficiently large especially in the case of the seasonal samples to provide statistically sound information (Table 1).

In *B. bengalensis,* the prevalence of pregnancy or proportion of pregnant females was maximum in the spring sample, less in the fall sample, lesser in the summer sample, and nil in the winter sample. The embryonic litter size varied from 9.6 in the spring to 10.8 in the fall.

In *M. musculus,* the prevalence of pregnancy was maximum in the fall sample when it was 70.0%. It was followed by 63.6% in the spring, 46.7% in the summer, and 14.3% in the winter. Thus, the process of reproduction in the mouse was greatly depressed during the winter season. The embryonic litter size averaged larger in the fall sample as compared to that of the spring and summer litters. In the winter sample there was only one pregnant female which carried five embryos in its uterus. In case of *R. meltada,* the prevalence of pregnancy was higher in the spring sample as compared to those of the fall and summer samples. No pregnant female was recorded in the winter sample. The litter size in the seasonal samples varied from 5.5 to 6.3, the largest average litter size was recorded in the fall sample.

From the above data, it appears that the bandicoot rat and the field rat ceased to reproduce during the winter season, whereas in the house mouse the process of reproduction did not cease completely but it had greatly decelerated during the winter months. All the three species produced somewhat larger litters in the fall. The bandicoot rat achieved maximum prevalence of pregnancy in the spring season, the house mouse in the fall and the field rat in the summer.

DISCUSSION

The rise and fall of the rats and mice populations in the croplands seem to be related to (a) the temporal changes in reproduction rates in the rodent populations, (b) inter - crop movements in response to changing conditions in the fields, and (c) the area of the fields under a given crop available for the rodent infestation. At certain times of the year particularly following the harvesting of the wheat and rice crops, and subsequent ploughing of the fields, the rodent populations are suddenly deprived of cover and food resources over a large area. Consequently, they are forced to migrate to the fields offering food and shelter. Deep ploughing and flooding of the recently harvested wheat or rice fields lead to high mortality in rodents especially in subterranean rodents like the bandicoot rats. Forced migration, increasing desiccation and paucity of suitable cover after the harvesting of the wheat crop in April and May take a heavy toll of the rodent populations. Migration in itself is a hazardous activity because the migrating animals become more vulnerable to predation (Metzgar, 1967). During the spring season when the climatic conditions are conducive, there is a surfeit of food and cover in the wheat fields, the rodents reproduce intensively (Khan, 1982). But the impact of the spring productivity is hardly visible past the month of April. Intuitively, the rodents dislodged from the wheat fields die on a mass scale.

A similar sort of thing happens after the rice crop is harvested in October and November and the fields are ploughed and prepared for the sowing of wheat. In the rice-based croplands of Sindh, the rats and mice are known to achieve high rate of reproduction during the ripening and maturing periods(Fulk *et al.,* 1981). A similar trend was perceptible in Alipur murid populations which achieved high to moderate prevalence of pregnancy and produced larger litters during the fall. As a result of sudden changes brought in the rice fields due to harvesting and subsequent ploughing of the fields, the rodent populations which had been building up in the rice fields through reproduction and immigration under moderate weather conditions, were suddenly exposed to hazards of migration and paucity of suitable habitat. Seemingly, they suffered high mortality before they could find habitable fields with sufficient food and shelter. But such fields are not in plenty at that time of the year. Furthermore, as the temperature falls the rate of reproduction in rodent populations declines and fmally stops. Resultantly, the rate of growth in these populations becomes negative. In such wheat-rice based cropland, as was the present study block, the rats' and mice find refuge mainly in the vegetable and sugarcane crops. Consequent upon the events that follow the harvesting of the rice crop, the size of the rodent populations decreased but their population density greatly improved due to concentration in the small area under vegetable and sugarcane fields, and the stackyard. In the predominantly wheat-rice based cropland of Alipur, small scattered fields of sugarcane may be used as 'trap fields' for attracting the rodents dislodged from the rice fields in October and November. It is not difficult to foresee that cultivation of sugarcane on larger scale in the croplands like that of the Alipur study block will favour the rats and mice greatly.

Control Implications: Concentrations of rodents in the fields of such minor crops as vegetables, fodders, and sugarcane and the stackyard,' which jointly covered 18% of the area of the study block in June, may be destroyed through poison baiting in June well before they begin migrating to the rice fields. Poison baiting may be repeated in these crops, if necessary, in October-November before the rodents start infesting the wheat fields. The individuals surviving the October-November treatment will have no chance to build up their populations because during the winter months they become reproductively quiescent or, at least, greatly decelerate the process of reproduction. The chances of rodent immigration from outside the protected area will be very little because of two reasons: (1) during the winter months the rodent populations will be shrinking due to cessation of reproduction; and (2) the food and cover conditions will be greatly improving over a vast area under the wheat crop not only in the protected area but all over the cropland. By the time the young of the season will be weaned and recruited to the above ground population, food and shelter conditions in the wheat fields improve so much all over the cropland that the possibility of migration resulting from shortage of food and shelter will be very negligible.

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