# MONGOLIAN RANGELANDS: RODENT PROBLEMS AND APPROACHES TO ALLEVIATE DAMAGE

**DALE L. NOLTE**, Denver Wildlife Research Center USDA/APHIS/ADC, 9701 Blomberg Street, Olympia, Washington 98512.

ABSTRACT: Rodents are a major constraint to forage production for livestock in Mongolia. A technical program to identify the magnitude of the problem and strengthen the research capabilities of Mongolian rodent specialists was initiated in 1994. The Brandt's vole is the most widespread and the most detrimental rodent to the steppes of Mongolia. Limited resources inhibit activities by the Mongolian Plant Protection Service to reduce rodent populations. Alternative means to monitor vole activity were developed. Laboratory and field trials showed that voles were susceptible to zinc phosphide treatment and indicated how bait acceptance could be improved.

KEY WORDS: Brandt's vole, forage depredation, Mongolia, zinc phosphide

Proc. 17th Vertebr. Pest Conf. (R.M. Timm & A.C. Crabb, Eds.) Published at Univ. of Calif., Davis. 1996.

## INTRODUCTION

Rodents are a major constraint to forage availability for livestock production on Mongolian rangelands. A technical program to address rodent problems in Mongolia was initiated during 1994 by the United Nations Food and Agricultural Organization (FAO) in cooperation with the Mongolian Ministry of Agriculture. The objectives of this program were to identify the magnitude of rodent problems and to strengthen the Mongolian national capabilities in integrated pest management.

An initial evaluation of rodent damage incidence and current use of rodent control methods was conducted during the spring of 1994. Information on agricultural resources and the incidence and control of rodent damage was obtained through visits with Mongolian scientists and farmers during this and subsequent trips. Cooperative field and laboratory trials helped to develop alternate strategies and to train local scientists on rodent research methods.

## MONGOLIA

Mongolia is a landlocked country in Central Asia (42-50° latitude and 88-120° longitude) located between Russia and China. Covering approximately 1.5 million square kilometers, Mongolia is roughly the size of the United States west of the Rocky Mountains. The central region of Mongolia is steppe or grassland; the Gobi Desert covers the southern part of the country. Northern and western Mongolia is mountainous. Mongolia is one of the least populated countries in the world with a population of 2.2 million people. Nearly 1 million of these people live in the capital city of Ulaan Baatar.

The Mongolian economy is heavily dependent on its agricultural resources. Nearly 80% of Mongolia's land and half of its working population are engaged in agriculture. Extensive grasslands, 132 million ha, provide the base for its animal production. Traditionally, nomadic lifestyles permitted the ready movement of livestock to available forage resources. Though traditional lifestyles persist, regional and social ties have reduced the extensive movements of the past.

The primary grasses are bluegrass (*Poa pretensis*), smooth brome (*Bromus inermis*), and crested wheatgrass (*Agropyron cristatum*). Sheep, goats, cattle, horses, and camels raised on these grasslands produce meat, wool, leather and milk for domestic consumption, as well as provide Mongolia's principle exports, including about 30% of the world's cashmere.

Arable lands, 1.3 million ha, extend across the country, however, the majority of crop production occurs in the central region. State owned and cooperative farms are being privatized and converted to share-holding companies and private farms. Principle grain crops include wheat, barley, oats and millet. Potatoes are the primary vegetable, along with cabbages, carrots, onion and garlic. Crop production in Mongolia has declined in recent years because of structural changes, shortages in fertilizer and fuel, and an inadequate distribution system. Mongolia imports flour, sugar and sunflower seed oil.

Mongolia's agricultural production suffers from severe climatic conditions. The weather is characterized by long and harsh winters (October to April). The cropping period is generally around 110 days, however, in some years it can be limited to as few as 80 days. Scarce precipitation (avg. 117 mm) occurs generally as rain during July and August and as snow during the winter (Lavrenko and Karamysheva 1993).

## BRANDT'S VOLE

Mongolian Plant Protection Service (PPS) specialists regard the Brandt's vole (*Lasiopodomys brandti*) as the most destructive of the 67 rodent species present in Mongolia. Though population densities fluctuate, it is estimated that the Brandt's vole infests over 40 million ha of rangelands; 19 million ha contain densities as high as 2,000 to 3,000 individuals per ha.

The Brandt's vole is the most widespread rodent of the steppe zone of Mongolia. Strictly herbivorous, the vole is an important competitor for domestic livestock and its activities are clearly perceivable on the steppe region (Weiner et al. 1982). Small stores of forage are hoarded by voles in the summer, but as winter approaches the voles exert their energies to gathering forage for the winter. Voles may store as much as 10 kg of dry forage per hole (Lavrenko and Yunatov 1952). Numerous pits are formed and the ground surrounding burrows often becomes barren. Voles ingest not only the above ground herbaceous matter, but also dig up the roots, slowing recovery of the vegetation. Due to this intense vole feeding activity, the plant species within a vole colony are generally altered to a less favorable composition for livestock production (Zielinski 1982).

Burrow entrances are connected by intertwining runways. Burrows can be divided into three types: refuge burrows, main summer burrows, and main winter burrows (Schauer 1987). Refuge burrows are of simple construction and short. They are located along the edges of main burrows and are used as shelter to avert danger. Summer burrows are a more complex structure but do not contain storage chambers. Winter burrows may have up to 30 entrances and a complex network of passages (3.5 to 4 cm) near the soil surface. The nesting chamber (dia. 30 cm) is located in the center at a depth of approximately 40 cm and surrounded by large oblong storage chambers (45 to 120 cm).

Seasonal climatic conditions greatly effect the above ground activity of voles (Anti-epidemic and Health Station 1975). During the summer the voles demonstrate bimodal above ground activity in the morning and evening. Seldom do they come to the surface at night. In late fall and early spring activity is primarily at mid-day. During the long, cold winters the animals seldom surface.

Fecundity in the Brandt's voles is high and during the course of a year, and over longer two to six year periods, its numbers fluctuate greatly (Schauer 1987). Voles have at least two to three litters per year, with five to nine pups per litter (Bannikov 1948). Offspring are generally first encountered in mid-May, and these first born produce their own young by July.

The economic consequences of the Brandt's vole to Mongolian agricultural are severe. Highly infested areas are virtually void of forage for livestock and associated grain fields can be devastated. Mongolian scientists report that more than 80% of the vegetation is consumed by rodents during the growing season. Losses on these areas are estimated to be 228 million metric tons of grain and between 226 and 304 million metric tons of natural forage. Though losses are less severe on the other 21 million hectares infested with Brandt's voles, they can still be substantial.

Lethal measures to reduce vole populations are the only approaches used by the PPS to alleviate rodent damage problems. Toxicants are generally applied in the spring (March to May) and then again in the fall (October to November). Prior to 1990, approximately 2 million ha of grassland were treated annually. Economic constraints in recent years, however, has limited the PPS efforts to slightly more than 100,000 ha per year.

Principal toxicants that have been used in Mongolia are zinc phosphide (50 to 60/kg bait), redentine (chlorophacinone: 3g/kg bait), bromdiolone (40g/kg bait) and *Salmonella enterides* (2mlrd/g). Zinc phosphide generally is applied in areas with high vole populations to quickly reduce densities. Anticoagulants are used in areas with less dense populations or as a follow-up treatment to maintain low rodent densities. The PPS also applies *Salmonella enterides* to approximately 23,000 ha (550g/ha) during the spring. The major deterrent to salmonella application is its potential hazards to humans and livestock.

Baits are applied almost exclusively from an airplane. High mountainous regions makes these applications difficult and limited fuel resources further hamper application efforts. Bait spreaders mounted on tractors are used to treat some small areas.

Wheat coated with sunflower seed oil is the only bait used to entice rodents to ingest toxicants. Wheat is readily available and is recognized by Mongolian specialists as an adequate bait. However, since most baits are aerially applied and remain on the soil surface until collected by rodents, it would be desirable to develop a bait that was avoided by livestock. An alternative bait would also be beneficial on croplands. Rodents restrict their intake of treated wheat when untreated wheat is readily available.

## DEMONSTRATION ACTIVITIES

Trials were implemented to demonstrate several possible alternative approaches to monitor vole activity, and to demonstrate the efficacy of different zinc phosphide concentrations to reduce vole populations.

### Animal Activity

At present, population densities of Brandt's voles are estimated by multiplying the number of active burrows entrances per ha by the constant 0.392. This constant was derived by Russian scientists through observations of vole activity relative to population densities. The number of burrow entrances is determined by collapsing all burrow entrances within a given area, then returning the next day to count entrances reopened within a 24 hour period. Generally, Mongolian scientists monitor four 1/4 ha plots per 10,000 ha. This approach is used to monitor population fluctuations across the country, as well as to evaluate the efficacy of population reduction measures.

Monitoring four 1/4 ha plots per 10,000 ha permits only isolated sampling. Belt transects were examined as an alternative to sample a greater number of smaller plots. The number of burrow entrances on 15, 1/4 ha plots was determined by the traditional burrow count method and with a belt transect method. The traditional burrow count method consisted of four persons walking back and forth across the plots counting all open burrow entrances. For the belt transect method (50 x 1 m), a 50 m tape was strung across each plot at five randomly selected points, and then all burrows within .5 m of either side of the tape were counted.

A one-way analysis of variance revealed that the traditional system (2,082 burrow entrances/ha) and the belt transect method (2,213 burrow entrances/ha) estimated similar vole activity. These results suggested that the belt transect method would be a feasible alternative to the traditional method. This method would enable the PPS to more thoroughly stratify their sampling of rodent populations across infested areas.

A modified point-sampling method was also examined as a means to monitor changes in relative vole activity. For comparative purposes, activity data were collected on three 1/4 ha plots. Open holes were counted by the plot count method on two consecutive days as described above. The point method consisted of locating the three burrow entrances nearest to 25 randomly selected points within each plot. Holes were then filled with rolled paper. The following day, burrows not blocked with paper were considered active. The paper was then replaced in the burrows and the process repeated the next day.

A two-factor repeated measures ANOVA was used to assess differences in activity estimates determined by the plot method and the point sampling method. The two methods indicated similar ($\underline{P}=0.22$) proportional declines ($\underline{P}<0.01$) in activity from day 1 to day 2. Thus, the modified step point may be a feasible alternative to evaluate changes in rodent activity. Additional efforts would be necessary to determine the optimal number of burrow entrances near a point, as well as the number of points necessary to accurately estimate changes in vole activity. Trapping methods to monitor rodent populations were also examined. Sherman live-traps (8 x 9 x 23 cm) were placed at approximately 5 m intervals on a 10 x 10 grid. Trap openings were located either along runways or near a burrow entrance. Snap traps, located on a plot approximately 1 km from the live trap plot, were also set along runways or near burrow entrances at 5 m intervals on a 10 x 11 grid. All traps were baited with wheat coated with sunflower seed oil.

Trap success by either method was very low (Table 1). Trap methods were halted after the third day because a substantial number of traps had disappeared. Efforts to improve trapping techniques were not attempted.

Table 1. Brandt's voles caught on live trap and snap trap grids on three successive days.

| | | Live Trap | | Snap Trap | |
|---|---|---|---|---|---|
| Day | Time | Male | Female | Male | Female |
| 1 | AM | traps set | traps set | traps set | traps set |
| 1 | PM | 1 | 1 | 0 | 1 |
| 2 | AM | 1* | 0 | 1 | 0 |
| 2 | PM | 0 | 0 | 0 | 1 |
| 3 | AM | 1 | 1 | 1 | 0 |
| 3 | PM | 0 | 0 | 0 | 0 |

*Male that was previously captured on Day 1, PM.

Population Reduction

The PPS applies approximately 3 kg of wheat treated with 5 to 6% zinc phosphide per ha, based on recommendations developed some years ago. Applying zinc phosphide at such concentrations might be counterproductive to an effective program (Tkadlec 1990). Lower concentrations of zinc phosphide are adequately lethal and rodents generally restrict intake of baits treated with high concentrations. Laboratory and field trials were implemented to determine the response of Brandt's vole to wheat treated with different concentrations of zinc phosphide.

The laboratory trial was conducted to complement the concurrent field trial by demonstrating vole susceptibility to low concentrations of zinc phosphide, and by demonstrating vole reluctance to ingest wheat treated with high concentrations of zinc phosphide. Treatment foods were whole wheat coated with sunflower seed oil containing 0%, 0.75%, 1.5%, 3.0%, 6.0% and 9.0% zinc phosphide. Another treatment that consisted of malted wheat coated with sunflower oil treated with 3.0% zinc phosphide was also included in the trial.

Fifty-six adult Brandt's voles were randomly assigned to one of the seven treatments. All animals were caged (48 x 27 x 20 cm) individually with free access to water throughout the trials. On day 1, after a three hour food deprivation period, voles were presented their respective treated foods in a two-choice test. Untreated wheat placed at the opposite end of the cage was the alternative choice.

All voles given wheat treated with zinc phosphide died within 12 hours; most of them died within 2 hours. Three of the eight untreated reference voles also died within the first 12 hours of the study; an indication that animals were probably stressed and a longer acclimation period should have been provided. Regardless, these results indicated that zinc phosphide at concentrations as low as 0.75% were lethal to Brandt's voles. Mean intake of food ingested across treatment was 0.1 g, suggesting that voles were licking the treated sunflower seed oil from the kernels rather than ingesting the wheat.

Low food intake negated attempts to evaluate the potential of malted wheat as an alternative bait. Malted grains may enhance bait acceptance because the malting process substantially increases sugar content relative to untreated wheat (B. A. Kimball, USDA/APHIS/ADC/DWRC, pers. comm.). Sweet flavors are generally attractive to rodents (Jacobs et al. 1977).

The field trial was conducted to determine the efficacy of two zinc phosphide treatments. One application reflected the current approach using 3 kg of bait per ha treated with 6% zinc phosphide. The amount of bait was doubled for the other application (6 kg/ha) but was treated with 1.5% zinc phosphide.

The trials were established 60 km west of Ulaan Baatar, near Argalant on a uniform grassland steppe of predominately bluegrass and crested wheatgrass. The two applications described above and an untreated reference treatment were randomly assigned to one of three 150 ha (1 x 1.5 km) plots. A 1 km border was established between plots to minimize crossover effects.

Baits were prepared by the PPS staff. Treatments were applied by a tractor mounted spreader. Bait dispersal rate was determined by counting the number of wheat seeds on the ground per $m^2$ (20 to 25 seeds/$m^2$ = 3kg/ha; 40 to 50 seeds/$m^2$ = 6 kg/ha). Vole activity within each of these plots was determined on five 1/4 ha sampling plots. Sampling plots were placed in a line at 100 m intervals such that the middle plot was in the center of the 150 ha plot. Activity before and after treatment was determined by the standard plot count method used by PPS staff in Mongolia. Vole activity was determined for the two consecutive days immediately prior to treatment, for two consecutive days one week after treatment, and then again for two consecutive days at approximately four months post treatment. Differences among treatments within each evaluation period was assessed by a Chi-square goodness of fit test ($\underline{P}$ = 0.05).

Activity was similar across all plots prior to treatment. One week after treatment, there were fewer active burrows on either of the treated plots than on the reference plot. The 1.5% zinc phosphide treatment plot had fewer active burrows than did the plot treated with 6.0% zinc phosphide. The number of active burrows on the reference plot four months after treatment was substantially greater than on the baited plots. However, after four months there were more active burrows on the 1.5% zinc phosphide plot than on the one treated with 6.0% zinc phosphide bait.

Vole activity was lower on plots treated with either concentration of zinc phosphide relative to the reference plot (Figure 1). Vole numbers were substantially less on treated plots than the untreated plot by the end of the summer, probably because reproductive adults were eliminated early in the year. This not only reduced the number of litters born to over-wintering animals but also restricted subsequent litters born to their offspring. The initial greater reduction on the 1.5% plot may have been because voles more readily accepted wheat treated with the lower zinc phosphide concentration. Results of the laboratory trial, however, suggest they would ingest sunflower seed oil treated with either concentration. A more plausible explanation is the increased amount of bait applied to the 1.5% plot. Doubling the amount of bait greatly increased the likeliness that treated kernels fell near burrows or on runways and were encountered by voles. It is uncertain why vole activity was lower on the 6.0% plot than the 1.5% plot after four months. Perhaps because a lethal concentration of zinc phosphide remained longer on wheat treated at the higher concentration than on the 1.5% bait. Therefore, this bait effectively removed voles that encountered it for a longer time after treatment than did reduced concentration.

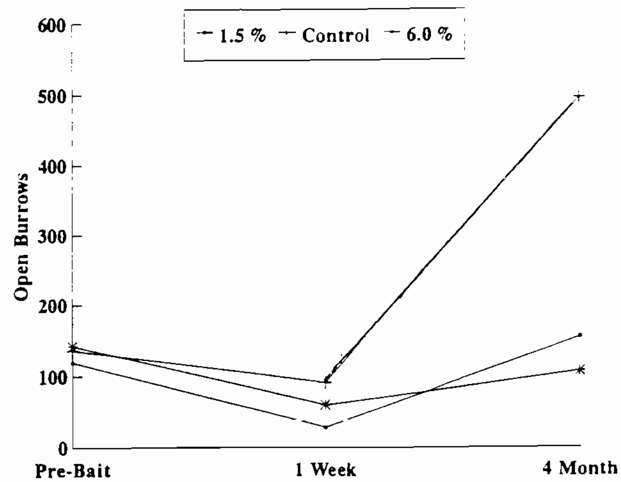


Figure 1. The number of active (open) Brandt's vole burrows on plots at pre-baiting, and at one week and four months post-baiting with wheat treated with 0% (control), 1.5%, and 6.0% zinc phosphide.

## SUMMARY

Populations of Brandt's voles, particularly in the southeast of Mongolia, disrupt livestock production. For example, 1,317 camps in the Suh-baatar region with 359,500 livestock were forced to move 200 to 300 kilometers to another region. These moves drain limited financial resources, disrupt social services and children attending school, and often cause increased competition among livestock for already limited forage resources.

The Mongolian PPS continues to work to reduce rodent depredations of grasslands. Additional means and resources, however, are needed to enhance its ability to identify problem areas reliably, identify more effective and safer rodenticide treatments, improve bait formulations, and enhance treatment procedures.

## ACKNOWLEDGMENTS

The efforts of the Mongolian Plant Protection Service staff to provide information regarding their program and on Mongolian agriculture, as well as their efforts to install cooperative trials was greatly appreciated. This work was conducted with funds contributed to the Animal and Plant Health Inspection Service/Animal Damage Control/Denver Wildlife Research Center by the United Nations Food and Agriculture Organization for implementing the FAO Project TCP/MON/4451 "Weed and Rodent Control." Use of trade names in this manuscript is for the purpose of identification and does not indicate endorsement of commercial products by the U.S. Department of Agriculture.

LITERATURE CITED


ANTI-EPIDEMIC AND HEALTH STATION OF SILINGE OF SILINGE MENG OF THE INNER MONGOLIA AUTONOMOUS REGION. 1975. An ecological study of Brandt's voles (*Microtus brandti*). Acta Zool. Sinica. 21:30-39.

BANNIKOV, A. G. 1948. Materials on Mongolian mammals, 2. Grey voles (*Microtus*), lemmings (*Lagurus*), mole-voles (*Ellphius*). Byull. Mosk. Ova. Ispyt. Prir. 53:19-36.

JACOBS, W. W., G. K. BEAUCHAMP, and M. R. KARE. 1977. Progress in flavor research. Pages 1-20 *in* R. W. Bullard, ed. Flavor Chemistry of Animal Foods. ACS Symposium Series 67, Washington D.C.

LAVRENKO, E. M., and Z. V. KARAMYSHEVA. 1993. Steppes of the former Soviet Union and Mongolia. Pages 3-59 *in* R. T. Coupland, ed. Ecosystems of the World, Vol. 8: Natural Grasslands. Elsevier Science, Amsterdam.

LAVRENKO, E. M., and A. A. YUNATOV. 1952. The regime of fallow land as influenced by field vole in steppe vegetation and soils. Bot. Zh. 37:128-138.

SCHAUER, J. 1987. The effect of the vole *Microtus brandti* on the soil of Mongolian steppes. Folia Zool. 36: 203-214.

TKADLEC, E. 1990. Optimum concentration of zinc phosphide in rodenticidal baits against the common vole (*Microtus arvalis*). Folia Zool. 39:227-236.

WEINER, J., W. GRODZINKSI, A. GORECKI, and K. PERZANOWSKI. 1982. Standing crop and above-ground production of vegetation in arid Mongolia steppe with *Caranga*. Pol. Ecol. Stud. 8:23-29.

ZIELINSKI, J. 1982. The effect of the Brandt vole colonies upon vegetation in the Caragana steppe of Central Eastern Mongolia. Pol. Ecol Stud. 8:41-56.

# IMPACTS OF FIELD-DWELLING RODENTS ON EMERGING FIELD CORN

**SCOTT E. HYGNSTROM, KURT C. VERCAUTEREN,** and **JASON D. EKSTEIN,** Department of Forestry, Fisheries and Wildlife, University of Nebraska, Lincoln, Nebraska 68583-0819.

ABSTRACT: The Conservation Reserve Program (CRP) has produced nearly 600,000 ha of exceptional wildlife habitat in Nebraska. Unfortunately, several species of rodents that inhabit CRP grass fields cause damage to agricultural crops. The emergence of corn seedlings in a 4-row strip of no-till field corn, planted in a 64 ha bromegrass field in northeastern Nebraska was examined. The most common rodent species in the study area was the deer mouse (*Peromyscus maniculatus*), of which 18 were captured within 10 m of the planted strip during one evening (400 trap nights). Corn seedling emergence in unprotected control areas [$\bar{x}$ = 19.2 plants/dekameter of row (dor)] appeared to be lower than in areas protected with welded wire exclosures ($\bar{x}$ = 23.7 plants/dor). An in-furrow application of 2% zinc phosphide pellets (2.75 kg/ha) also contributed to an increase in emergence ($\bar{x}$ = 21.9 plants/dor). Differences among the treatments, however, were not significant (P = 0.76). Additional research is needed to develop methods to reduce wildlife damage in crop fields that incorporate conservation tillage practices or are adjacent to or converted from CRP fields.

KEY WORDS: deer mouse, rodents, wildlife damage

Proc. 17th Vertebr. Pest Conf. (R.M. Timm & A.C. Crabb, Eds.) Published at Univ. of Calif., Davis. 1996.

## INTRODUCTION

The United States Congress passed the Food Security Act of 1985 (16 USC 3831-3840, Public Law 99-198) to reduce crop surpluses and stabilize agricultural commodity prices. Several conservation provisions were included in the Act that provided incentives to landowners nationwide to implement land management practices that reduce soil erosion and increase water quality. These conservation provisions, also known as the Conservation Reserve Program (CRP), led to the conversion of nearly 14 million ha of cropland to untilled land in semipermanent vegetative cover by 1996. These large fields of predominantly cool and warm season grasses provide exceptional habitat for wildlife. Recent publications have documented increased populations of ring-necked pheasants (*Phasianus colchicus*) (King and Savidge 1995; Riley 1995) and songbirds (King and Savidge 1995) due to the current CRP. Other long-term federal farm programs, such as the Soil Bank Program initiated in 1956 and the Crop Adjustment Program of 1965, have also contributed significantly to wildlife habitat (Erickson and Wiebe 1973). Unfortunately, some rodents and birds that inhabit these fields cause damage to agricultural crops. Voles (*Microtus* spp.), field mice (*Peromyscus* spp.) and ground squirrels (*Spermophilus* spp.) dig up and eat planted seeds and/or clip off emerging seedlings, usually before the fourth-leaf stage. Elton (1942) wrote of exceptionally high vole populations (2,500 voles per ha) in agricultural fields prior to the advent of effective herbicides and clean farming practices. He also provided anecdotal accounts of dramatic crop failures due to rodent plagues. More recent reports of rodent damage to emerging corn seed and seedlings in conservation tillage fields have varied considerably: 1% in Iowa (Young and Clark 1984), 5% to 8% in Nebraska (Holm 1984), 50% to 60% in Illinois (Beasley and McKibben 1975, 1976) and 80% to 100% in Illinois (Hines 1983). To a lesser extent, field-dwelling birds such as ring-necked pheasants and horned larks (*Eremophila alpestris*) pull up and eat emerging seedlings. Although wildlife damage can be locally severe, few cost-effective methods are available to control such damage. In 1989, the U.S. Environmental Protection Agency (EPA) withdrew label clearance for the use of zinc phosphide-treated bait on field corn for rodent control. Currently, there are no toxicants or repellents registered for in-field application to reduce damage by small rodents.

Concern has been expressed by the agricultural community regarding the potential impacts of wildlife on crops that are planted in fields that incorporate conservation tillage practices or are adjacent to or converted from CRP fields. In addition, there is commercial interest in developing a toxicant formulation that provides cost-effective and environmentally safe protection for crops planted in conservation tillage systems. A research/demonstration project was conducted to address these concerns. The objectives were to: 1) determine the impact of rodents on no-till corn planted in a bromegrass field previously enrolled in the CRP; and 2) determine the efficacy of in-furrow applications of zinc phosphide for controlling rodent damage to no-till corn seed and seedlings.

## METHODS

This study is part of an interdisciplinary project conducted at the University of Nebraska Northeast Research and Extension Center, near Concord, Nebraska. The project is being conducted by the "CRP to Crops Team," which includes nine scientists from the following disciplines: agricultural engineering, agronomy, entomology, forestry, soil science and wildlife. Team members are working to identify the most cost-effective and environmentally sound means of converting land from the CRP back into agricultural production. The rodent damage study was conducted in a 64 ha CRP field planted to bromegrass in 1986. A 5 m wide, 500 m long strip was delineated in an East-West direction in the northern half of the bromegrass field. The strip was shredded with