Experimental assessment of rodent control on two poultry farms of central Argentina

I. E. Gómez Villafañe,*†[1] F. O. Miñarro,*[2] L. Valenzuela,*[3] and D. N. Bilenca*†

**Departamento de Ecología, Genética y Evolución, Facultad de Ciencias Exactas y Naturales, Universidad de Buenos Aires, 4° piso, Pab. II, Ciudad Universitaria (C1428EHA), Buenos Aires, Argentina; and †Consejo Nacional de Investigaciones Científicas, Avda. Rivadavia 1917, CP C1033AAJ, Cdad. de Buenos Aires, Argentina*

Primary Audience: Flock Supervisors, Researchers, Veterinarians

SUMMARY

We experimentally assessed the effect of controlling vegetation height along farm perimeters on the abundance of rodents in 2 broiler poultry farms in central Argentina. We carried out an experimental design based on the before-after–control-impact method. After vegetation treatments, there was a significant decrease in rodent abundance at the perimeter of the farm with control of vegetation height because of the reduction of the Pampean grassland mouse *Akodon azarae*. In poultry houses, there was a significant decrease in rodent abundance on nonaffected farms because of the reduction of the commensal house mouse *Mus musculus domesticus*, possibly because of a major collocation of rodenticide. Our results indicate that both the control of vegetation growth at the perimeters and the appropriate timing of rodenticide applications are effective measures for rodent control on broiler poultry farms when both control measures are applied simultaneously. We achieved effective rodent control through an understanding of the habitat use and population dynamics of the species involved and the characteristics of the area where the control program would be applied.

Key words: rodent, broiler poultry farm, vegetation, control, Argentina

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DESCRIPTION OF PROBLEM

Rodent control is a priority in rural areas, where rodents can cause widespread damage, including consumption and contamination of food, structural damage to building components and equipment, production loss, and spread of diseases and ectoparasites [1–3].

Traditionally, rodent control methods have included poisoning, trapping, rodent-proofing, and environmental modifications. More recently, it has been emphasized that the success of rodent control may rely on knowledge of the species composition of the rodent community, as well as on an understanding of habitat use and population dynamics of the species involved and the characteristics of the area where the control program will be applied [1, 4].

In the agro-ecosystems of central Argentina, the small mammal assemblage includes at least

[1]Corresponding author: isabelgv@ege.fcen.uba.ar
[2]Fundación Vida Silvestre Argentina, Defensa 251 Piso 6 "K" (C1065AAC) Buenos Aires, Argentina.
[3]Department of Biology, University of Utah, 257 South 1400 East, Salt Lake City, UT 84112.

11 rodent species. Many of these rodent species are agricultural pests in crop fields and poultry farms and act as disease reservoirs [5–9]. The most abundant species are the sigmodontine rodents *Calomys laucha* (small vesper mouse, head-body length 72 mm), *Calomys musculinus* (vesper mouse, head-body length 96 mm), *Akodon azarae* (Pampean grassland mouse, head-body length 80 to 105 mm), *Oligoryzomys flavescens* (Argentine rice rat, head-body length 80 to 95 mm), *Oxymycterus rufus* (common-burrowing mouse, head-body length 80 to 115 mm), and the murine *Mus musculus domesticus* (house mouse, head-body length 65 to 90 mm). *Calomys* are granivorous-herbivores and are numerically dominant in crop areas, whereas the onmivorous-insectivorous *Akodon* is more abundant in less disturbed habitats, including field edges, fencerows, roadsides, and grasslands [5]. *Mus* are omnivorous and are closely associated with human dwellings and farms [9].

Most species show a strong seasonal variation in population in crop areas and borders and on poultry farms, with a minimum in late winter and spring, and a maximum in summer and early autumn, followed by a drastic decline [5, 9]. Reproduction of rodents in rural areas is also seasonal and the breeding season may last 6 to 9 mo [5].

Previous studies carried out on poultry farms in this region revealed that rodent infestation is positively associated with the percentage of the perimeter of the farm covered with vegetation, the amount of plant cover above 20 cm in height, the condition of houses where chickens are kept, and the location of the house within the farm [7, 8]. Houses located at the perimeter of the farm showed higher rodent abundance than houses located between other houses on the same farm [8]. Moreover, houses that were nearer to the perimeter of the farm were more likely to be infested with sylvan species than those with a wider separation from the perimeter [9]. Regarding methods for chemical control of rodents on Argentine poultry farms, previous studies revealed no relationship between the time lag since the last application of rodenticide and rodent infestation [7]. Possible reasons for this phenomenon may be related to deficient management practices because houses may remain untreated for several months, either because the company does not provide the rodenticide or the farmer decides not to use it [7].

Although previous studies have described associations between habitat features or management procedures and rodent infestation on poultry farms in Argentina, no studies have assessed whether there are any cause-effect relationships between these associations. Thus, the goal of this study was to assess experimentally the effect of controlling vegetation growth along the perimeter of farms on the abundance of rodents on poultry farms in central Argentina.

MATERIALS AND METHODS

Study Area

The study was carried out from November 1999 to June 2002 at 2 broiler poultry farms in the district of Exaltación de la Cruz, Buenos Aires Province, Argentina (34°S, 59°W). The farms are representative of the characteristics of broiler poultry farms in the region, based on previous studies conducted in the study area [7–9].

The main agricultural activities in the study area are cropping, cattle production, and poultry farming. Soybean, corn (*Zea mays*), sunflower, sorghum, or pasture fields frequently surround the broiler poultry farms. The climate is temperate, mean annual temperature is 16°C, and annual rainfall averages 1,000 mm.

Description of the Broiler Poultry Farms

Both broiler farms were equipped with gas heating and artificial lighting systems and were operated by the same breeding company, following identical procedures regarding feed supply, rodenticide, and vaccines.

Poultry farm 1 (2.24 ha), hereafter called **PF1**, included 2 houses of 100 × 10 m. The farm was surrounded by 2 crop fields and 2 pastures. Poultry farm 2 (3 ha), hereafter called **PF2**, included 5 houses of 100 × 10 m surrounded by 3 crop fields. The broiler farms were ≥100 m apart (i.e., a distance that is at least 3 to 5 times larger than the average movements reported for the studied rodent species) [10–14]. Thus, the observations at both farms were considered independent.

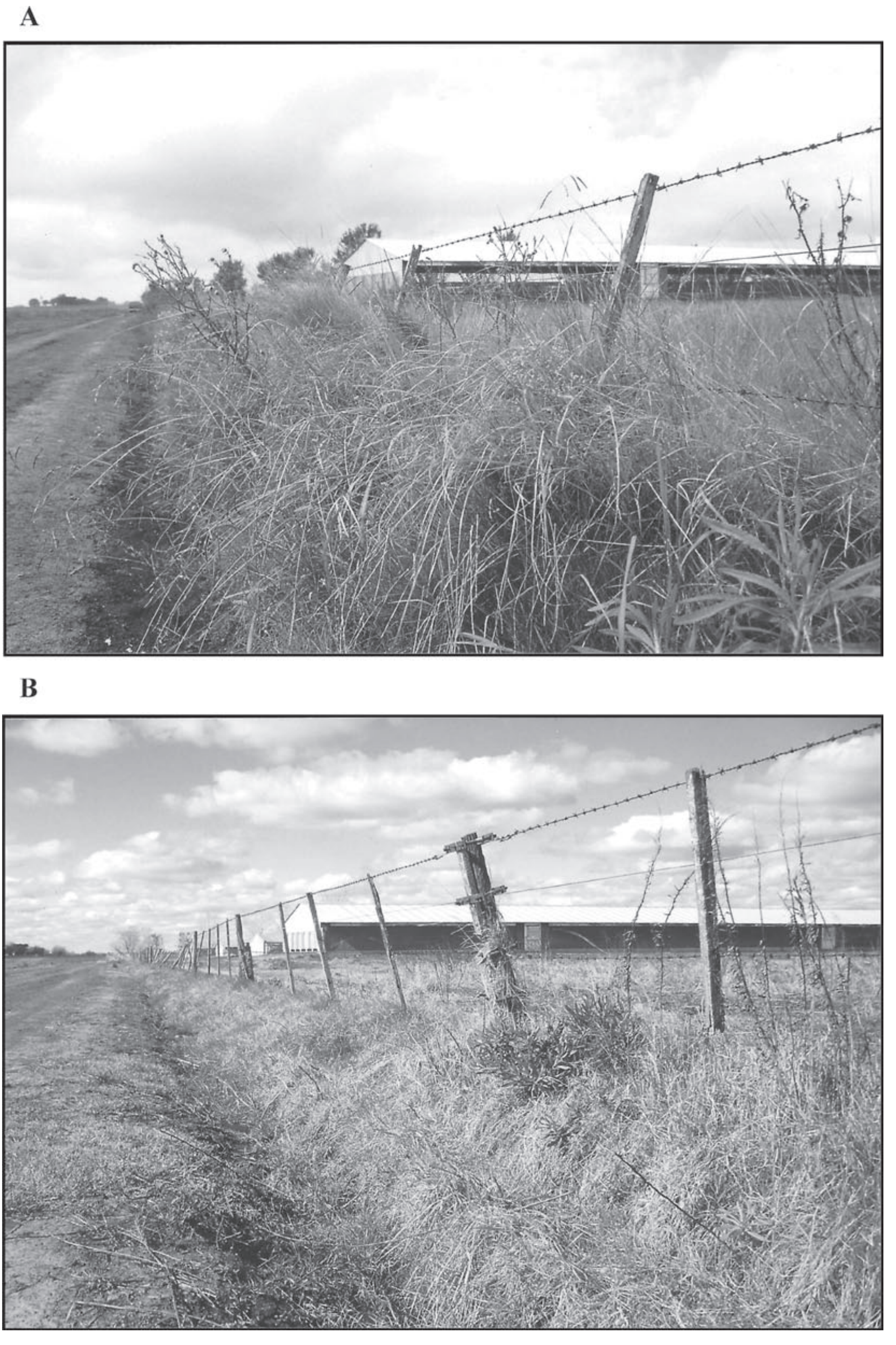

Figure 1. Perimeter of poultry farm 2 before (A) and after (B) the control of vegetation growth.

Experimental Design

The experimental design was based on the before-after–control-impact (**BACI**) method [15, 16]. One site was sampled before and after the implementation of management. The other site was left untreated (nonaffected site) and was sampled at the same time. The assumption was that any naturally occurring changes, such as seasonal variation in rodent abundance, would be about the same at the 2 sites, and any extreme changes at the potentially affected sites could be attributed to the treatment.

Based on results of a previous study [7], we applied the treatment of controlling vegetation growth at the perimeter of farm PF2 by both mechanical (tractor and motor-scythe) and chemical methods (herbicide) after the time of management. Farm PF1 acted as a nonaffected site (Figure 1; vegetation control applications maintained the vegetation height below 20 cm.).

Following the BACI experimental design, we conducted 8 rodent samplings simultaneously on both poultry farms before beginning the vegetation treatments (November 1999 to September 2000) and 7 rodent samplings after applying the vegetation treatments (July 2001 to June 2002) to evaluate changes in rodent abundance attributable to treatment. Changes in the structure or management practices on farms were not detected during the period without sampling (October 2000 to June 2001). At each sampling, we recorded the total abundance and overall composition of rodent species in the houses as well as at the perimeter of the farm.

Rodents were captured with Sherman live traps [17] baited with a mix of peanut butter and bovine fat. Traps were spaced at 10-m intervals and were active for 3 consecutive nights around the external perimeters of houses and at the perimeters of the farms. Moreover, we set traps in the surrounding fields to check for the movement of rodents between poultry farms. The trapping effort included 800 trap nights per sampling time.

For each captured animal, we recorded the species, sex, reproductive condition, and weight. Animals were then marked with ear tags and released at the point of capture. The abundance of each rodent species was estimated by its trap success as the number of captures × 100/number of active trap nights [5] for each sampling.

Trap success was used because it is a reliable index [18, 19] associated with absolute abundance [20] and is widely used as an estimator of the abundance of rodents. Additionally, we registered the dates of application of rodenticide in each farm.

Data Analysis

Consistent with the BACI method [15], the difference in trap success (**dTS**) was compared between poultry farms (affected site minus nonaffected site) before (8 trapping sessions) and after time of impact (7 trapping sessions) by means of the Mann-Whitney test [21]. We carried out a test of the perimeters of the farms and a test of the houses separately (i.e., we compared the dTS for the perimeter and the houses, respectively).

RESULTS AND DISCUSSION

A total of 1,190 rodents were trapped, including 656 *M. musculus domesticus,* 321 *A. azarae*, 193 *Calomys* spp. (including *C. laucha* and *C. musculinus*), 16 *O. flavescens* and 4 *O. rufus*. *Mus musculus domesticus* was the most abundant species trapped around the outside of the houses (838 captures, corresponding to 638 individuals), followed by *Calomys* spp. (50 captures; 36 individuals), *A. azarae* (32 captures; 15 individuals), and *O. flavescens* (6 captures; 6 individuals). *Akodon azarae* was the most abundant species trapped at the perimeters of the farms (433 captures corresponding to 222 individuals), followed by *Calomys* spp. (57 captures and 44 individuals), *M. musculus domesticus* (13 captures; 13 individuals), *O. flavescens* (11 captures; 10 individuals), and *O. rufus* (4 captures corresponding to 4 individuals). *Calomys* spp. were most abundant in the crop fields surrounding the farms (154 captures; 113 individuals), followed by *A. azarae* (145 captures; 84 individuals) and *M. musculus domesticus* (6 captures; 5 individuals). No rodent movement was detected between farms. All individuals were recaptured on the same farm.

On both farms, the rodenticide, coumatetralyl 0.75% (formulation: 1 part of active ingredient in 19 parts of wheat; coumatetralyl 0.0375%) [22] was placed in the poultry houses in the period when the chickens were absent. The rodenticide was placed inside the poultry houses in circular

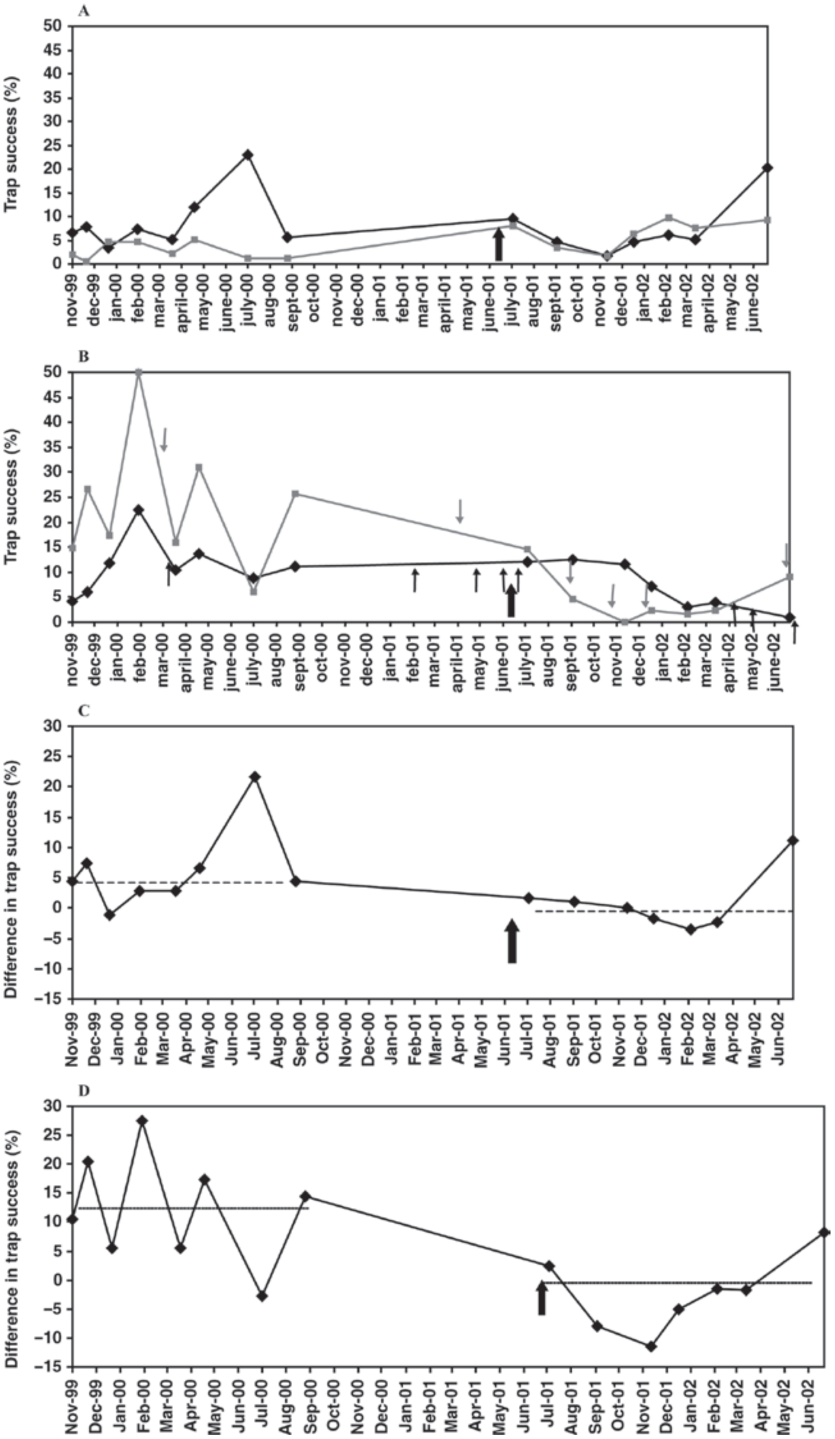

Figure 2. A) Rodent trap success at the perimeters of the affected farm (PF2; black line with diamonds) and the nonaffected farm (PF1; gray line with squares) from November 1999 to June 2002. B) Rodent trap success in houses of the nonaffected farm (PF1; gray line with squares) and the affected farm (PF2; black line with diamonds). C) Difference in trap success at the perimeters of both farms. D) Difference in trap success in the houses of both farms. The large arrows indicate the beginning of vegetation treatment application. The small arrows indicate the time of rodenticide applications on each farm. The dotted lines are the median difference in trap success (dTS) before and after impact.

containers, under each chicken feeder and on the ceilings. However, on PF1 the rodenticide application was more systematic than on PF2, as shown in Figure 2B.

Figure 2 shows variations in rodent trap success (Figure 2A and 2B for the perimeters and houses, respectively) and in the dTS between farms PF1 and PF2 (Figure 2C and 2D) before and after application of the vegetation treatment. Before application of the vegetation treatment (November 1999 to June 2001), trap success at the perimeters of PF2 was higher than at the perimeters PF1, whereas after application of the vegetation treatment (June 2001 to June 2002), trap success at the perimeters of both farms tended to be similar (Figure 2A and 2C). Conversely, before application of the vegetation treatment, trap success at the houses on PF1 was higher than at the houses on PF2, whereas after the application of treatments, trap success at the perimeters of both farms tended to be similar (Figure 2B and 2C). Consequently, there were statistically significant differences in rodent trap success between farms before and after application of the vegetation treatment (Figure 2C and 2D; Table 1).

The significant decrease in the dTS between the perimeters of the two farms was mainly associated with a significant decrease in the abundance of *A. azarae* at the perimeter of PF2, the farm treated for control of vegetation growth (Table 1). There was no detectable effect on the other species analyzed (Table 1). The significant decrease in the dTS between farms in the houses was associated with a reduction in the abundance of *M. musculus domesticus* at the houses of PF1 (Table 1). However, and strikingly, there was a marginally significant increase in *Calomys* species at the houses on PF1 after application of the vegetation treatment. The results experimentally corroborate a previous hypothesis [7] that controlling vegetation growth at farm perimeters can effectively reduce rodent abundance in this habitat. The results are also in agreement with other studies showing the effects of habitat manipulation in reducing rodent damage [23, 24].

The presence of many common field dwellers, such as *A. azarae* and *Calomys* spp., in the houses on farms suggests movement of the rodents between the houses and the surrounding habitats [9]. Thus, a reduction in the height and cover of vegetation at the perimeters may reduce the ability of the perimeter to act as a corridor between the 2 habitats [25, 26]. In addition, controlling the vegetation at the perimeter reduces the availability of food and shelter, thus reducing the carrying capacity of the habitat and the number of *A. azarae*.

Surprisingly, in this study, we observed a major reduction in the commensal species *M. musculus domesticus* in the houses on the nonaffected farm compared with the affected farm. The trapping data showed that *M. musculus domesticus* was more abundant in poultry houses and was almost absent at the perimeters or in the crop fields. This observation suggests that the abundance of *M. musculus domesticus* on the farms would depend mainly on its breeding

Table 1. Comparison of the difference in trap success (dTS) of rodents between poultry farms (affected site minus control site) before and after the application of vegetation treatments at 2 poultry farms in Exaltación de la Cruz District, central Argentina

Habitat	Rodent species	Median dTS[1] before	Median dTS after	U[2]	*P*-value
Farm perimeters	Total rodents	4.50	−0.03	10.00	*
	Mus musculus	0.00	0.00	26.50	0.862
	Akodon azarae	4.63	−0.03	10.00	*
	Calomys spp.	−0.02	−0.01	26.00	0.817
Houses	Total rodents	12.54	−1.67	6.00	**
	M. musculus	12.16	−2.88	3.50	**
	A. azarae	0.00	0.00	22.50	0.524
	Calomys spp.	0.00	1.21	12	†

[1]dTS = trap success in affected poultry farm minus trap success in nonaffected poultry farm (before = before impact time; after = after impact time).

[2]U = Mann-Whitney U tests.

†$P \leq 0.10$; *$P \leq 0.05$; **$P \leq 0.01$.

success in the houses rather than from recruitment or movement from the surrounding habitats. The reduction in *M. musculus domesticus* abundance in the houses of PF1 was associated with a more regular and systematic schedule of rodenticide application in these houses because the abundance would not be compensated for by migration from the surrounding fields. The marginal increase in *Calomys* species in the houses of the nonaffected farm after the reduction of *M. musculus domesticus* suggests that the removal of *M. musculus domesticus* in the houses may create a vacuum, allowing the invasion of rodents from surrounding fields when perimeter vegetation is not reduced [9].

CONCLUSIONS AND APPLICATIONS

1. For effective and long-lasting management of pests on poultry farms, the optimal strategy includes efficient use of chemical methods (i.e., regular timing); knowledge of the composition, habitat requirements, and distribution of rodent species; and regular control of the vegetation cover at the borders.
2. Specifically, in this system, the slashing of grass along fencelines would be lower in winter, and the optimal time of slashing would be in the period when the chickens are absent and the farmers have less work. However, winter is the best season to apply rodenticide, in the houses as well as at the farm perimeters, because the rodents are in reproductive recess. The control of abundance in this period will result in a lower peak density in summer to autumn because there would be smaller numbers of rodents to reproduce.
3. In spring, the frequency of vegetation treatment would be increased and the application of rodenticide should continue.
4. In summer, the frequency of application of the vegetation treatment is maximal, when the chickens are absent as well as when they are present. Additionally, the abundance of rodents is increased and migration could occur. With adequate control of vegetation below 20 cm, the possibility of the perimeters acting as a corridor is avoided.
5. In autumn, the frequency of slashing is intermediate but the abundance of rodents is highest.
6. The application of rodenticide should continue throughout the year. The best places are above the ceilings and under feeders when the chickens are absent. When chickens are present, the rodenticide should be placed above the ceilings and on the floor, covered and near the wall to prevent access of the chickens to the rodenticide.

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