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THE HOUSE MOUSE IN POULTRY OPERATIONS: PEST SIGNIFICANCE AND A NOVEL BAITING STRATEGY FOR ITS CONTROL

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ABSTRACT: Enclosed and insulated commercial poultry buildings provide ideal habitat for supporting unusually large populations of the house mouse (Mus musculus L.). Mice cause damage to various structural and operational components of poultry facilities; thus, they are of economic significance as well as general nuisances. Effective mouse control programs in poultry operations are often difficult, complicated, time consuming and inefficient due to various environmental and operational factors intrinsic to commercial poultry facilities. The significance of the house mouse as an economic pest in poultry operations is discussed via the results of a rodent control survey of 161 commercial poultry operations in Indiana. Survey data are presented concerning mouse problem incidence and severity, mouse damage, and mouse control tools and methods operators judged most successful. A research project aimed at developing more cost-effective and efficient methods of controlling mice in commercial poultry operations was begun at Purdue in 1985. The project involves the development of a novel rodenticide baiting strategy utilizing customized PVC anticoagulant bait stations, second-generation anticoagulant baits, and a "time-pulse" baiting strategy. Preliminary field trials of this baiting technique have produced population reductions of 78.8% and 74.4% in two poultry houses following a one "pass" application rate. Research addressing additional application rates is continuing as well as investigations into modifications of this baiting strategy for application in other types of poultry and livestock operations.

INTRODUCTION

The house mouse (Mus musculus L.), is one of the most common mammals found in and around livestock and farm operations, where food and harborage are readily available and abundant. In particular, enclosed and insulated commercial poultry buildings provide ideal artificial mouse habitat which can accomodate unusually large mouse populations. Such populations can have significant economic impact to poultry operations. House mice consume feed as well as contaminate it with urine and feces, gnaw on structural, mechanical, electrical and various utility components, and weaken various types of concrete slabs and walkways via their burrowing activities. More important, however, is the damage that mice do via the destruction of building insulation during their nesting, burrowing/gnawing activities. Also, rodents in general are potential vectors of several livestock diseases, e.g., erysipelas, fowl cholera, salmonellosis (Meehan 1984). But the significance of the house mouse as a vector of poultry diseases has not been documented. The monetary economic losses to poultry operations from mouse infestations are difficult to assess accurately. Operational shutdowns due to electrical or mechanical malfunctions as a result of mouse damage can cost poultry operators thousands of dollars. The repair and/or replacement of building insulation is expensive in both dollars and time. And long-term energy losses due to damaged or lost insulation magnifies the expense.

Compounding the economic significance of the house mouse in poultry operations is the fact that effective, long-term rodent control in these operations often is difficult--especially in enclosed egg-layer and pullet facilities which produce the most extensive rodent infestations (Ashton and Jackson 1986). The difficulty can be attributed to several factors:

1) Commercial poultry structures provide rodents (mice, in particular) with almost unlimited habitat. In egg-layer facilities which utilize dry shallow and deep pit manure collection systems, mouse habitat occurs within the soil below slab walkways, within dried manure, and in the walls and attic spaces. What is more, rodents are able to establish themselves homogeneously throughout these habitats measuring up to $1500m^2$ or more. Thus, mouse habitat may be limited only by the size of the structure itself. As a result, poultry buildings have produced some of the largest densities of house mouse populations ever recorded (Berry 1981). Selander (1970), using mark-and-recapture methods, estimated mouse densities of 3,000 mice/$414m^2$ (70,000 mice per hectare) in Texas chicken barns. Corrigan (unpubl. data), used repeating catch traps for 25 days to capture and remove 1,800 mice/$864m^2$ (approx. 21,000 mice per hectare) in an Indiana poultry house.

2) Poultry operators may not be aware of the severity of an infestation (due in part to the nocturnal behavior of the mice) or fully comprehend the scope (e.g., 3-dimensional mouse distributions, continual immigrations) of an infestation (Ashton and Jackson 1986). Nor may the operators understand the thoroughness with which a mouse control program needs to be conducted. Consequently, mouse control efforts often are grossly incomplete and result in cycles of underbaiting--mouse "harvests"--population rebounds--underbaiting...etc. Of course, such programs are highly nonproductive, inefficient, costly, and frustrating for poultry operators.

3) Poultry operators may find it difficult or costly to provide the time and/or labor necessary to administer rodent baits in the necessary quantities (e.g., the placement of several hundred bait stations throughout a poultry operation, or thorough hand placements of baits directly in mouse harborages) required for an effective program and then to maintain such a program long term.

4) Rodenticide baits used in control efforts must compete with the copious amounts of food (chicken feed, eggs, and insects) constantly available to the mice. Thus, high quality baits need to be utilized to maximize bait acceptability.

Despite the seriousness of the mouse problem in poultry operations, discussion of mouse control for poultry operations is relatively scarce in the formal literature. Ashton et al. (1983) conducted rodenticide efficacy studies on resistant house mice in pullet operations in Indiana, and Ashton and Jackson (1986) discussed efficient and inefficient methods of rodent control in turkey and pullet operations using the rodenticide diphacinone. Purushotham et al. (1984) conducted bromadiolone efficacy studies on poultry farms in India. Informal discussions of rodent control for poultry and other livestock operations appear regularly in various cooperative extension publications, e.g., Carlton 1975; Timm 1982, 1983; Thornberry et al. 1983; as well as in trade magazines (Poultry Tribune, Poultry Digest). Rodenticide product-promotional literature for poultry operations is also available from various product manufacturers (e.g., Callender 1983).

The objective of this paper is to discuss: 1) the significance of the house mouse as an economic pest in poultry operations via the results of a survey, and 2) an experimental but novel approach for controlling mice in egg-layer poultry facilities.

THE SIGNIFICANCE OF THE HOUSE MOUSE AS AN ECONOMIC PEST IN POULTRY OPERATIONS

A four-page survey-questionnaire containing 40 questions entitled Rodent Control For Poultry Operations (R. M. Corrigan and R. E. Williams) was developed and mailed to each member of the Indiana Poultryman's Association in the spring of 1984. This survey was a modification and expanded version of a survey conducted by Timm (1982) that addressed rodent and bird pests on swine production units in Nebraska.

The objectives of the survey were: 1) to gather data concerning the incidence and severity of the rodent problem in poultry operations; 2) identify the economic damage caused by rodents; and 3) gather data concerning rodent control materials and methods poultry operators were utilizing to combat rodents. Although the survey addressed both mice and rats, this paper will discuss only a few of the more pertinent points concerning the house mouse specifically. A detailed manuscript of the survey is in preparation.

The survey was mailed to 398 association members and 161 responses were received (40.4% response). Most respondents operated egg-layer (52.6%) or turkey (35.0%) facilities. The responses according to operation size are provided in Table 1.

Table 1. Response of rodent control survey according to the size of the poultry operation.

Total Number of Birds	n	%
< 1000	15	9.6
1001 - 10,000	29	17.8
10,001 - 20,000	33	20.5
20,001 - 50,000	43	26.7
50,001 - 100,000	18	11.0
100,001 - 1,000,000	18	11.0
> 1,000,000	5	3.4
Total	161	100.0

Mice were reported present in poultry operations during 1982 to 1984 by 88.5% of all respondents while only 11.3% responded as to not having any mice in their operations. But this response is of little significance because the house mouse is the most common mammal found in fields and structures in Indiana (Mumford and Whitaker 1982). A more specific response which addresses the severity of mouse infestations within poultry operations is provided in Table 2. Of significance is the result that 44.9% of the poultry operators reported the mice to be a "moderate problem," while 8.0% reported the mice to be a "severe constant problem."

Table 2. Severity of mouse problem according to type of poultry operation (n = 138).

	Severity of mouse problem					
	A few mice, of little concern		"Moderate problem," occasional nuisance		Severe, constant problem	
	n	%	n	%	n	%
Egg layer operations n = 74	34	46.0	33	44.5	7	9.5
Turkey n = 48	22	45.8	22	45.8	4	8.4
Other Operations n = 16	9	56.3	7	43.7	0	
Total	65	(47.1)	62	(44.9)	11	(8.0)

Poultry operators were asked to list the types of damage they sustained to their operations due to mouse infestations (Table 3). Most respondents listed wall insulation damage (67.4%), structural damage (31.8%), and feed consumption (31.8%) as most serious. When asked to estimate the actual dollars spent annually for mouse damage repairs, only 88 (63.7%) of the respondents reporting the presence of mice in their operations replied to the question. The estimates provided by this group for mouse damage were as follows:

$ 0.00 - 100.00	66 (75.0%)
101.00 - 500.00	15 (17.0%)
501.00 - 1000.00	3 (3.4%)
1001.00 +	4 (4.5%)

Most respondents expending more than $500.00 per year operated large poultry facilities and reported severe mouse problems (as might be expected). One commercial egg-layer operation reported spending between $10,000.00 and $15,000.00 in 1 year to replace conveyor belts damaged by mice.

Table 3. Poultry operators observations as to the type of damage occurring within poultry operations due to mice.

Type of damage	n[1]	%[2]
Damage to wall insulation	93	67.4
Structural (timbers, walls, doors)	44	31.8
Feed consumption	44	31.8
Feed contamination	28	20.3
Fire hazard (gnawing damage to electrical wires)	17	12.3
No damage	13	9.4
Disease	10	7.2

[1]Respondants could select more than one area.

[2]% response of n = 138 : those reporting the presence of mice in their operations.

Table 4 lists the materials and methods operators employed for mouse control. Poison baits were used by 89.9% of the operators (of this group, 93% used anticoagulant baits). Of interest is that 52.2% of the operators utilized cats in their operations to assist in rodent control. Other materials and methods, e.g., traps, making food less available, etc., received relatively low response rates, which may indicate that poultry operators considered rodent control methods other than poison baits and cats not practical for use in commercial operations. Table 5 lists those methods and materials the operators judged most successful. As illustrated, most operators (92.7%) relied on poison baits for their mouse control program, while only 23.6% considered cats to be successful in controlling mice.

Table 4. Methods of mouse control utilized by poultry operators.

Control method	n[1]	%[2]
Poison baits	124	89.9
Cats	72	52.2
Snap traps	15	10.9
Made food less available	14	10.1
Automatic traps (Ketch-All or Tin Cats)	9	6.5
Ultrasonics	6	4.3

[1]Respondents could select more than one method.

[2]% response of n = 138 : those reporting the presence of mice in their operations.

Table 5. Mouse control methods which poultry operators considered successful.

Control method	n[1]	%[2]
Poison baits	115	92.7
Cats	17	23.6
Snap traps	4	26.6
Made food less available	10	71.4
Automatic traps	5	55.5
Ultrasonics	1	16.6

[1]Respondents could select more than one method.

[2]% response percentage based upon number of respondents which used that particular method.

A NOVEL APPROACH FOR CONTROLLING HOUSE MICE IN EGG-LAYER POULTRY HOUSES

To address the mouse control-poultry operations problem, a research project was initiated at Purdue University in 1985. The primary objective of the project is to develop more effective and efficient methods of administering rodenticide baits within poultry operations. The research project is comprised of two facets: 1) utilization of a customized bait station novel to poultry operations; and 2) development of efficient baiting strategies specific for commercial egg-layer operations. This paper will report on the methodology of this research project and the results of some preliminary field trials. This project is currently ongoing.

MATERIALS AND METHODS AND PROCEDURES

Field Trial Sites

Field trials were conducted on natural commensal house mouse infestations in a shallow-pit egg layer operation in Monticello, Indiana. The operation is comprised of four layer houses measuring 120 m x (1440 m^2). Each house contains approximately 20,000 hens set up as four hens per cage. Manure is collected and removed from the houses every 3 months. From preliminary trapping studies, mice were found in abundance in all four houses and the populations appeared to be distributed homogeneously throughout the house. Mouse habitat was divided among the dry chicken manure, insulated walls and attic, and below the concrete slab walkways.

Bait Station

For a bait station to be effective in poultry operations, it should: 1) be sturdy and durable; 2) offer good bait protection from environmental (dust, dirt, water) and animal (chicken manure) contamination; 3) provide good bait containment characteristics (reduced bait spillage and nontarget access); 4) be capable of storing relatively large amounts (1 to 2 weeks' supply) of bait; 5) be easily serviced, cleaned, and maintained; and 6) offer a convenient and "attractive" feeding location to rodents.

The bait station utilized in this research project is a modified model of a PVC inverted-T anticoagulant bait station as described by Salmon (1981) (Figure 1). This bait station meets all of the criteria listed above.

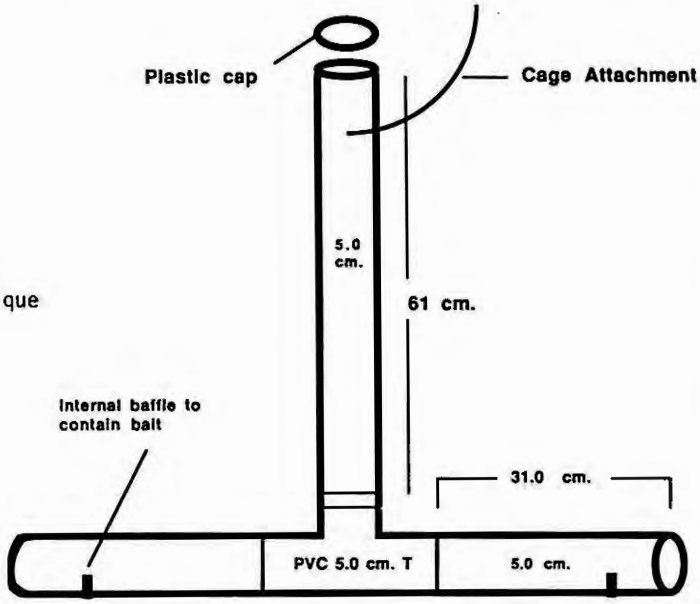

Figure 1. PVC inverted T anticoagulant bait station used for the T-station baiting technique in egg-layer poultry houses.

Baiting Strategy

The baiting strategy employed in this research project (referred to as the T-stations technique) utilizes a modified version of Dubock's (1979) pulsed baiting technique. The use of second-generation anticoagulants in conjunction with the pulsed baiting technique allows for the use of unique and customized baiting strategies for poultry operations. Dubock (1979) states that the techniques required for efficient use of the first-generation anticoagulants are often inappropriate in agricultural situations because the high labor and bait inputs required are often impractical, resulting in low efficacy of first-generation baiting programs. This statement is especially applicable to commercial poultry operations. The use of first-generation anticoagulants has utility in minor infestations and/or maintenance programs, but for intense control efforts, the newer rodenticides utilized in pulsed baiting programs offer a more efficient approach, with considerable potential for savings in labor and bait (Dubock 1979). The T-stations technique utilizes the pulse baiting concept; but whereas Dubock's technique recommends relatively little (5 to 10 g.) amounts of baits replenished weekly, the T-stations technique for poultry operations employs relatively large amounts of baits with few placements, and the baits being moved on a regimented time schedule throughout a poultry house. Thus, the T-stations technique is a "time pulse" baiting technique. The movement of the T-stations is conducted by poultry house personnel in the daily management operations within the houses. Thus it is time-efficient and practical. The technique as employed in the field trials is discussed below.

Each egg-layer house used as a trial site received 10 T-stations. Each station contained 2.0 kg. of brodifacoum (Talon®) pelletilized bait. Each pit received two T-stations stationed at opposite ends of the pits and arranged in a staggered configuration for each pit (Figure 2). The T-stations were placed directly below the hen cages with the base of the T-stations resting directly on the floor of the pit adjacent to the slab walkways. They were held in place by Velcro® strips attached from the top of the T-stations to the base of the hen cage directly above. Two T-stations were positioned along the wall area at one end (test plot) of the house.

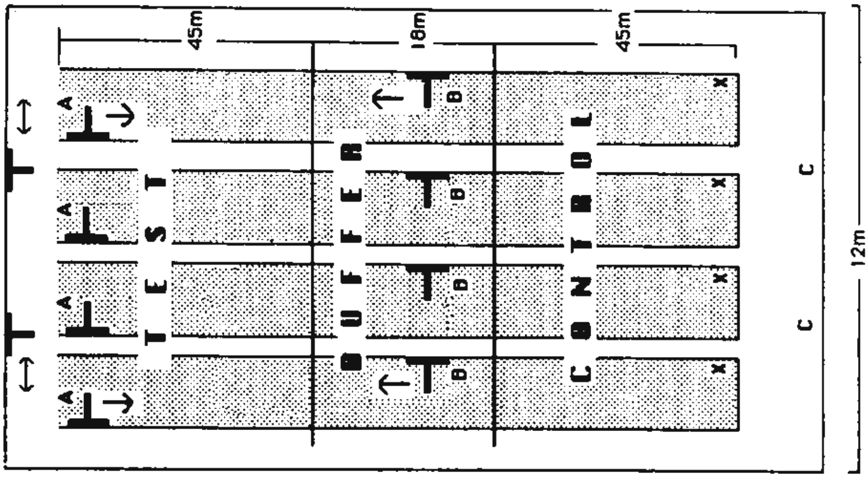

Figure 2. Field trial design for the T-station baiting strategy. In actual practice the "B" T-stations would be started at the pit ends (marked "x") and two additional T-stations would be positioned at points "C" along the end wall.

The pit T-stations were moved 3 meters every other day in the direction of the remaining unbaited test area. (Thus, it required 36 days for each of the pit T-stations to reach the midpoint of a house with a pit area measuring 108 m in length). The wall T-stations are simply moved along the wall in a back-and-forth sequence every other day. It is important to note that due to the unique baiting scheme and layout, a mouse will have access to the bait from at least one T-station within the mouse's territory for a minimum of two periods of 2 days for each period for the pass of the "A" T-stations and again for the pass of the "B" T-stations (i.e., a total of 8 days' bait exposure for a "one pass" (of all the T-stations) application rate). Mice occupying habitat between the T-stations located on the east-west axis are likely to have additional access to the bait. Furthermore, because this baiting strategy is designed to provide a continual bait application program in actual field use, it is likely that mice surviving the first pass (pulse) of the T-stations will be susceptible to the second, or any of the following pulses of baits. (In several infestations, when a faster knockdown is desired, four additional T-stations can be started at the center of the poultry house and moved in either direction to supplement the T-stations started at the ends of the pits.)

All structural areas outside of the actual poultry confinement area are also baited at the beginning of the T-station program to prevent immigration of mice into treated areas. (Areas such as storage rooms, coolers, and offices can also be baited using T-stations, or some of the smaller, more conventional mouse bait stations are used in these locations. For baiting insulated attic areas, place-type bait packets or paraffin blocks (during the nonsummer months) are often used).

Field Trial Design

Two of the four houses at the layer operation were selected at random and served as test houses. Test houses were then divided into three plots: 1) T-stations plot; 2) buffer plot; and 3) control plot (Figure 2). Determination of T-station plots and control plots within the test houses were also made at random.

The sizes of the mouse populations within each test house were estimated via a censusing technique utilizing live-capture traps and a food consumption census as described by Kaukeinen (1984). Victor Tin Cat® repeating-catch live traps were placed every 3 m within all pits. In between trap placements, small cardboard bait stations containing raisins were placed to measure food consumption. Sherman single-catch live traps, also spaced at 3-m intervals were placed along perimeter wall areas. Chicken feed and Nestlets® were placed within each trap to reduce captivity stress and cannibalism. Traps were checked early each morning, captured mice examined, recorded, and then released. The pretreatment and posttreatment census periods were conducted for 3 days each. The mean number of mice captured for the 3-day period was used as the population estimate[1]. The field trials required a total of 41 days (6 days' population censusing, 35 days' baiting) to complete.

Field Trial Results

Table 6 illustrates the results of the two field trials for the T-stations technique experiment. Population reductions of 78.8% and 74.4% were recorded for poultry house No. 1 and No. 2, respectively. It is important to note that these field trials measured population reductions achieved after only one "pass" of the T-station through the houses. In actual practice, with an ongoing maintained program, it would be expected that greater levels of control would be achieved. Trial programs of this baiting strategy are currently in place in three commercial egg-layer facilities in the Midwest that have severe mouse infestations. Feedback from these operations has been very positive. Operators have expressed the baiting strategy to be practical, convenient, cost-effective, and efficient.

[1]The food consumption data were not analyzed for the field trials.

Table 6. Population reductions of house mice in two field trials using the T-station/brodifacoum application technique with a one "pass" application rate.

House/Plot	Average daily captures[1] Pretreatment	Posttreatment	Percent[2] reduction
1			
Treatment (T-stations+bait)	116.3	24.6	78.8
Buffer	38.0	15.3	59.7
Control	54.3	67.3	-24.4
2			
Treatment	63.3	16.2	74.4
Buffer	22.6	12.5	44.6
Control	70.0	81.2	-16.0

[1]Treatment and control plots: 40 Tin Cat traps and 18 Sherman single-catch traps were used to census mouse populations. Buffer plots used 20 Tin Cats and 10 Sherman traps.

[2]Percent reduction = $\frac{\text{Pretreatment value - Posttreatment value}}{\text{Pretreatment value}} \times 100$

Research addressing additional application rates is continuing as well as investigations into modifications of this baiting strategy for application in other types of poultry and livestock operations.

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