

Report Title:

Field efficacy evaluation of “Natrocell Pro” rodenticide bait, containing the active substance powdered corn cob, for the control of Norway Rats, *Rattus norvegicus* (Berkenhout, 1769) infesting an agricultural holding on the Anglo-Welsh border

Trial Site:

Crickett Farm, Frankton, Ellesmere, Shropshire, UK

Field Work Completed on:

20th March 2006

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VPU Study Number: VPU/06/004

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1. SUMMARY

- 1.1 An infestation of Norway rats was found at a livestock holding, Crickett Farm, near Ellesmere on the Anglo-Welsh border. The farm is in the Welsh focus of anticoagulant resistance in which 50% of rats within infestations commonly carry the resistance gene. A preliminary site survey was carried out using a visual assessment of the extent of the infestation and this indicated that the site would be suitable for a rodenticide field efficacy trial, having a significant infestation of Norway rats.
- 1.2 Pre-treatment census baiting resulted in a total of 6.11 kg of whole wheat being consumed during the four-day period, with a maximum of 1.91 kg reached on the fourth night of census baiting. A tracking patch census carried out over the same period resulted in a total track score of 295 and a maximum track score, on the third night of the census, of 82.
- 1.3 98 “Natrocell Pro” baiting points were set out on the farm and, in accordance with the draft product label, 200 g of the formulation was put out on each. In addition, a further 47 rat burrows were marked and treated with bags of 100 g of “Natrocell Pro”. Any additional active rat burrows that were discovered during the application were treated likewise. Excellent bait takes were observed from the bait trays and baited burrows during the first week of the treatment. There were few takes of bait and signs of rat activity on the farm thereafter.
- 1.4 The operations of census baiting and the scoring of tracking patches were repeated in a four-day post-treatment census period. A total of 1.15 kg of census bait was consumed, with a maximum of 0.34 kg on the third night of the census. A total track score of 35 was recorded, with a maximum of 12 found on the first night of the census period. The overall efficacy of the treatment was estimated to be 81.2%, using the maximum census bait take, and 88.1% using the maximum track score. This level of control exceeds that commonly achieved against Norway rats in field trials of non-anticoagulant rodenticides.
- 1.5 There was an abundance of non-target bird species present at the site throughout the baiting period, as well as many non-target domestic stock and companion animals. No impacts of the bait application were observed on any non-target animals.

2. AIMS AND OBJECTIVES

- a. To apply “Natrocell Pro” rodenticide formulation on a livestock farm in order to control an infestation of Norway rats, *Rattus norvegicus* (Berkenhout, 1769), within the Anglo-Welsh border focus of anticoagulant resistance. This to be done in accordance with the pattern of use stipulated by the draft product label.
- b. To obtain information on the size and distribution of the rat infestation on the farm and to assess the efficacy of the formulation, according to efficacy evaluation guidelines given by UK regulatory authorities and the European Commission, using pre- and post-treatment assessments of tracking activity and the consumption of whole wheat census bait.
- c. To conduct and monitor the treatment on the farm, in accordance with the Study Protocol dated 13th September 2005. The treatment was run according to a good hygiene practice, which is replicable under practical conditions by farmers and professional pest control operators.

3. BACKGROUND

“Natrocell Pro” is a novel rodenticide bait containing the active substance powdered corn cob (EC Number, 310-127-6; CAS Number, 999999-99-4). Similar baits containing this active substance have been available in the U.K. and elsewhere for some time under the trade names “Eradirat” and “Eradimouse”. The active substance is in the process of authorisation through the European Commission’s Directive 98/8/EC concerning the placing of biocidal products on the market, with Greece as the Rapporteur Member State.

Limited information is available on the active substance in the public domain, although preliminary data on laboratory and field trials of another product based on powdered corn cob (“Rodetrol”) were presented by Grech *et al.* (2004). This work demonstrated the promise of products based on powdered corn cob for use in rodent pest management.

An extensive dossier of confidential studies is available however. Tests carried out in the U.S.A. and New Zealand have demonstrated the efficacy of powdered corn cob bait in no-choice feeding tests against individually caged rats (Kable, 2002; Hoyer, 2002a; Morgan and Eason, 2003) and mice (Hoyer, 2002b; Morgan, 2003a). A series of further studies has demonstrated safety to a range of non-target animals including Mallard duck, chicken, rabbit, ferret, cat and dog (Morgan, 2003b-g).

Preliminary field efficacy tests have also demonstrated the effectiveness of the active substance (Grech *et al.*, 2004) and the purpose of the trial that is the subject of this report was to investigate the performance of “Natrocell Pro” during a field treatment of an infestation of Norway rats using a field trial protocol that complied with current European standards, including those from the European and Mediterranean Plant Protection Organization (EPPO/OEPP, 1999) and the U.K. Pesticides Safety Directorate (Anon., 2000).

4. TRIAL SITE

Crickett Farm, Frankton, Ellesmere, Shropshire, UK

Holding Number: 35/156/0153

Map reference: SJ 364 346

Elevation: 90 metres A.M.S.L.

Type of Site: sheep, dry cows and calves

Acreage: 100 ha

Crops Grown: Grass silage and maize silage

Livestock: 30 dry cows, 25 calves, 4 ponies, 1 horse

Domestic animals: 4 cats.

The site is located near the village of Perthy 3 km west of the small town of Ellesmere, Shropshire (Plate 1). The surrounding countryside is mainly grassland, used for dairy farming and the rearing of cattle and sheep. The buildings are constructed from a range of materials including steel, concrete block, tin sheet, and traditional brick and slate. See field trialist's field notes (Appendix 1).

The last treatment of an infestation on this site was carried out in January 2002 with "Neosorex" bait containing difenacoum.

The rats at the site were identified visually as *Rattus norvegicus*. No other rat species is known to occur in the vicinity of the farm. Rat infestations in the area frequently contain about 50% of individuals that carry the gene which, when expressed phenotypically, is known as "Welsh warfarin resistance" (Rost *et al.*, 2005; Pelz *et al.*, 2005).

Sources of alternative food for rats were abundant at the trial site. Two of the three large silage pits shown (Figure 1) were empty at the time of the trial but the third contained a large quantity of silage maize. Rats were harboured in the hollow galvanised steel panels which supported the silage clamp (Plate 6). Also, there was a flat store containing a large quantity of calf feeder pellets inside the cattle barn (Plate 7). Various mangers and feed troughs were placed for stock feeding in several areas of the cattle barn from which silage and feed pellets were available to the rats.

Plate 1. Crickett Farm buildings – the main barn. The site of the field trial of “Natrocell Pro”.



Plate 2. A view of some of the infested farm buildings showing marked rat burrow in the banks of the slurry pit behind the main barn.



5. MATERIALS AND EQUIPMENT

5.1 Test formulation:

The formulation used at the trial site, “Natrocell Pro”, was a pellet formulation supplied by Ilex Organics Limited, P.O. Box 158, Market Rasen, LN8 3WR, U.K.. The active substance was powdered corn cob (IUPAC name), CAS Registry Number 999999-99-4, EC Number 310-127-6. Batch numbers for the samples of “Natrocell Pro” used in the trial which were provided by Ilex Organics are given in Appendix 2. The confidential statement of formula for the formulation used is given in Appendix 3.

5.2 Bait Trays

The bait trays used were constructed from 8 mm softwood and measured approximately 150 mm x 100mm, with a rim of approximately 8mm (Plate 3).

Plate 3. Plywood bait tray with whole wheat census bait.



5.3 Tracking Patches

Horticultural Silver Sand was used for tracking patches. These were at least 100mm x 150mm, with sufficient depth to ensure a flat surface (Plate 4).

Plate 4. Horticultural sand tracking patch



5.4 Census bait

The census bait used in the pre- and post-treatment assessments of rat activity was whole dry wheat. This was obtained from a local grain merchant.

5.5 Balance

A Hanson Gourmet Scale (tolerance $\pm 2.5\%$) was used for all measurements of mass conducted in the field. The balance was calibrated weekly with calibration weights of 100 g, 20 g and 2 g.

6. TRIAL PROCEDURE

6.1 Protocol Overview

The trial was conducted under an Automatic Experimental Permit (AEP 207) issued by the Health and Safety Executive, Bootle, Merseyside, L20 3QZ, on 13.10.05, amended on 30.11.05 and 22.02.06. The trial was conducted under the Home Office License for animal procedures held by Dr Colin Prescott, and complied with all animal welfare requirements under current U.K. statutes. The Vertebrate Pests Unit of the University of Reading is officially recognised by the U.K. Pesticide Safety Directorate as an efficacy testing facility for Vertebrate Control.

The protocol for the field trial, agreed with the Trial Sponsor prior to the commencement of the trial, is given in Appendix 4. The trial procedure was conducted in accordance with the Standard Operating Procedures of the Vertebrate Pests Unit, University of Reading. Recommended procedures for the estimation of the field efficacy of rodenticides are provided by the Pesticide Safety Directorate (Anon., 2000), the Health and Safety Executive (Anon., 2002) and the European and Mediterranean Plant Protection Organization (EPPO/OEPP, 1999). Further information on proof of product efficacy for to the Biocidal Products Directive (Commission Directive 98/8/EC) is also available from the European Commission (Anon., 2003).

There were six main stages in the Procedure (see Trial Diary below, section 6.2):

1. survey and placement of census bait and tracking patches;
2. pre-treatment bait census and recording of track scores;
3. lag period;
4. test treatment and recording of bait take and track scores;
5. lag period;
6. post-treatment bait census and recording of track scores.

1) Survey and placement of census bait tray and tracking patches (09.02.06)

A map of the 'trial site' was produced on Monday 6th February, 2006, and copied for later data recording. A qualitative assessment was made of the rat population at Crickett Farm at the same time and this showed a significant moderate rat infestation to be present at the site (Figure 1). Tracks and droppings were evident in most areas. There were several rat active burrows and runs on the banks of the slurry pit situated at the back of the main cattle shed (Plate 2). There were also obvious signs of rats harbouring in the hollow wooden separators between the silage clamps and in many other localities on the farm.

Census bait trays and tracking patches were laid on day -3 (09.02.06), four days before the start of the pre-treatment assessment census, to allow the rodents to become accustomed to them. A total of 65 census bait points (Figure 2) and the same number of tracking patches (Figure 3) were positioned across the whole of the trial site in positions that were protected, wherever possible, from disturbance. Where appropriate, materials readily available on the farm were used to provide additional protection.

2) Pre-treatment bait census and recording of track scores (trial week 1: beginning 13.02.06, days 1 to 7).

On the first day of the assessment census, the census bait trays were filled with 200g of dry whole-wheat, and the tracking patches were smoothed over with fresh horticultural sand. Each day, baits were weighed and replenished, and tracking patches were recorded and smoothed over. For the next four days:

- the amount of bait at each point was weighed (± 1 g) and then replenished to 200g, where necessary increasing the amount of wheat to avoid complete takes,
- tracking patches were scored using the following scale, and then smoothed over with fresh horticultural sand. The scoring procedure was as follows:

0 = no sign of rodent tracks

1 = 1-5 individual rodent footprints

2 = >5 footprints and up to 25% of patch covered with footprints

3 = 26%-95% of patch covered with footprints

4 = > 95% of patch covered with footprints

At the end of the census all bait trays and census bait were removed, but tracking patches were left *in situ* for monitoring during the subsequent trial phases.

3) Pre-treatment Lag period (trial week 2: beginning 20.02.06, days 8 to 14).

The only visit to the trial site during this period was to set out the treatment trays on day 11 (23.02.06). The treatment trays were distributed across the whole of the 'test site'. Wherever possible, their positions were not the same as that of the census trays, although for practical reasons some were in close proximity. A total of 98 treatment trays was used (Figure 4).

4) Rodenticide application and recording of bait take, both from trays and from hole baiting, and track scores (trial weeks 3 - 4: beginning 27.02.06 –days 15 to 28)

A search was carried out prior to bait application for carcasses of target and non-target species.

Tracking patches were smoothed over with fresh sand on day 15 (27.02.06) and this procedure was repeated daily (except week-ends) immediately after the recording of track score throughout the treatment period.

Rodenticide bait was also first laid on day 15 at the rate of 200g per bait point in accordance with "Natrocell Pro" label recommendations. A thorough search for rat burrows was also conducted over the entire site. These were baited with 100g of bait per burrow. Burrow baits were held in domestic "cling film" (plasticised polyvinyl chloride film) to prevent scattering and to keep them dry to some extent. As more burrows were found during the treatment period, these too were baited in the same way. The positions of the baited burrows, eventually a total of 49 were marked with numbered sticks so that they could be found subsequently and an assessment of bait take could be made (Figure 5).

Bait consumption and activity recordings were made daily Monday to Friday. Bait points were replenished daily to 200g at each point where there had been a take of bait. Burrow baits were also checked, and replenished if required. More burrows were baited with 100g of "Natrocell Pro" as they were found.

In accordance with the Study Protocol, and after discussion with the Sponsor's representative on the site, the trial was terminated on day 29 (13.03.06), when all "Natrocell Pro" bait was removed from the bait trays. Bait was also removed, where possible, from rat burrows.

Non-target searches were carried out each day during the application of "Natrocell Pro".

5) Post-treatment Lag period (week 5: beginning Monday, 13.03.06, days 29 to 32)

No visits to the trial site were made during this period except for picking up the rodenticide bait from burrows, and laying post-treatment census bait trays, on day 30. Census bait trays were put out in the same positions as the pre-census bait trays (Figure 2).

6) Post-treatment recording of census bait consumption and track scores

(week 5: beginning Thursday 16.03.06 – days 32 to 36)

The post-treatment recording of census bait consumption and track scores was carried out in exactly the same way as in the pre-treatment census (see above). The trial was completed on day 36 (20.03.06).

6.2 Trial Diary – Duration - 36 days; baiting with “Natrocell Pro” - 14 days.

Day	Date		Activity
-3	09/02/2006	Thursday	position tracking patches and census bait trays
-2	10/02/2006	Friday	
-1	11/02/2006	Saturday	
0	12/02/2006	Sunday	
1	13/02/2006	Monday	put out post-treatment census bait
2	14/02/2006	Tuesday	post-treatment census
3	15/02/2006	Wednesday	post-treatment census
4	16/02/2006	Thursday	post-treatment census
5	17/02/2006	Friday	post-treatment census - remove census bait trays
6	18/02/2006	Saturday	lag period
7	19/02/2006	Sunday	lag period
8	20/02/2006	Monday	lag period
9	21/02/2006	Tuesday	lag period
10	22/02/2006	Wednesday	lag period
11	23/02/2006	Thursday	lag period - position rodenticide bait trays
12	24/02/2006	Friday	lag period
13	25/02/2006	Saturday	lag period
14	26/02/2006	Sunday	lag period
15	27/02/2006	Monday	initial rodenticide application
16	28/02/2006	Tuesday	weigh bait take from trays and replenish; check and replenish hole baits; record track score
17	01/03/2006	Wednesday	weigh bait take from trays and replenish; check and replenish hole baits; record track score
18	02/03/2006	Thursday	weigh bait take from trays and replenish; check and replenish hole baits; record track score
19	03/03/2006	Friday	weigh bait take from trays and replenish; check and replenish hole baits; record track score
20	04/03/2006	Saturday	no recording
21	05/03/2006	Sunday	no recording
22	06/03/2006	Monday	weigh bait take from trays and replenish; check and replenish hole baits; record track score
23	07/03/2006	Tuesday	weigh bait take from trays and replenish; check and replenish hole baits; record track score
24	08/03/2006	Wednesday	weigh bait take from trays and replenish; check and replenish hole baits; record track score
25	09/03/2006	Thursday	weigh bait take from trays and replenish; check and replenish hole baits; record track score
26	10/03/2006	Friday	weigh bait take from trays and replenish; check and replenish hole baits; record track score
27	11/03/2006	Saturday	no recording
28	12/03/2006	Sunday	no recording
29	13/03/2006	Monday	weigh bait take from trays and pick up; record track score; lag period
30	14/03/2006	Tuesday	lag period - pick up hole baits where feasible - position census bait trays
31	15/03/2006	Wednesday	lag period
32	16/03/2006	Thursday	put out post-treatment census bait
33	17/03/2006	Friday	post-treatment census
34	18/03/2006	Saturday	post-treatment census
35	19/03/2006	Sunday	post-treatment census
36	20/03/2006	Monday	post-treatment census - remove census bait trays - terminate trial

7. RESULTS

7.1 Pre-census activity

The locations of census bait trays and tracking tiles are shown in Figure 2 and Figure 3 respectively.

The total bait take was 6.11 kg during the four-day pre-treatment census period, with a maximum take of 1.91 kg on day 4 (16.02.06), the third of the census bait days (Table 1). The highest total tracking score, 82, on one day of pre-treatment was on day 3 (15.02.06) and the total track score for the four days was 295. Census bait trays were removed from the site on day 5 (17.02.06).

Various estimations can be made about the numbers of rats present at the site based on maximum census bait consumption. It is commonly said that rats consume approximately 10% of their body weight in dry food each day (Meehan, 1984). Also, it is reasonable to assume that the average weight of rats was 200g. If we make a further assumption, that rats ate only census bait during the 24-hour period during which 1.91 kg of bait was taken, we arrive at a conservative estimate of the rat population at the site of 95 rats. This is conservative as it is unlikely that rats completely refrain from eating other available foods.

The full data set from the pre-treatment census period, with information from individual bait points and tracking patches, is provided in Appendix 5 (census baiting) and Appendix 6 (tracking patches).

7.2 Lag Period

A lag period was applied between the days 5 and 15 (17.02.06 – 27.02.06) of the trial. During that time tracking patch assessments continued daily. A thorough search for rat burrows was also conducted over the entire site during this period and burrows were individually marked with a bamboo cane, with white painted tips for easy visibility, and a numbered metal tag. A total of 47 burrows were identified and marked in this way.

7.3 Pre-treatment body search

A search was made for animal carcasses (both target and non-target species) immediately prior to the application of “Natrocell Pro”. None was found.

7.4 “Natrocell Pro” treatment

The rodenticide bait was laid at the rate of 200g per bait point on day 15 (27.02.06), in accordance with recommended procedure on the product label. Great care was taken to ensure, as far as possible, that the bait remained dry. Bait points were serviced daily (see section 6.1).

On each service visit, bait at individual bait points was weighed and replenished with rodenticide in accordance with the Field Trials Protocol. Also on a daily basis, all rodent burrows were treated with a bag containing 100g of “Natrocell Pro”. Two new burrows were observed during the first baiting rounds and were also marked with sticks and baited.

Special efforts were made to keep the bait dry because the formulation was found to be highly hydrophilic. Some moisture had been found to enter the bait through the fabric of the wooden bait trays and, therefore, a process was used whereby the trays were wrapped in ‘cling film’ and the bait was laid on this material (Plate 5).

Plate 5. A bait tray with “Natrocell Pro” rodenticide bait. Domestic ‘cling film’ used to protect bait from moisture absorbed through the wooden bait tray.



When rodenticide baits are reasonably palatable, it is frequently the case that similar quantities of rodenticide bait are consumed on the first day of baiting as census bait on the first day of census baiting. This was found to be the case for “Natrocell Pro” at the Crickett Farm trial site. The consumption of whole wheat census bait was 1.21 kg on the first day of census baiting. Consumption of the rodenticide bait on the first day of baiting was 1.04 kg from the bait trays, and a further 1.15 kg was estimated to have been taken at the marked rodent burrows, although it was impossible to say with certainty that this bait had been completely consumed because the burrows were not excavated (see Appendix 7). These observations indicate that a very high proportion of the rats present probably took bait on the first night of baiting. The 200 g of “Natrocell Pro” bait was completely consumed only from two bait points (numbers 32 and 56 on day 15). This indicated that the label application rate was sufficient at this site and that the outcome of the treatment was not affected by under-baiting.

Data on bait takes from each of the bait trays during the period of the treatment is provided in Appendix 8.

The quantity of bait taken from the bait trays declined on the second day of baiting to only 0.56 kg (Figure 6), although the number of bait points with takes increased from 35 on the first day of baiting to 42 on the second. However, there was still a good take of bait from the baited burrows (estimated 1.30 kg) on the second night of baiting. The combined take from the trays and burrows (1.86 kg) again approached the maximum take of census bait, although it should be noted that a direct comparison of these values is inappropriate because the census bait was only offered from the bait trays. There was a significant decline in both the quantity of bait taken and the number of bait points with takes after the second day of baiting (Figure 6). Only 0.23 kg of bait was taken over the three-day week-end period (days 12 – 14) and, thereafter, there were no more measurable bait takes during the remainder of the treatment period.

The tracking tile census reached a peak score of 82 on day 3 of the trial (15.02.06) during the pre-treatment census period (Figure 7). Rat activity observed on tracking patches during the first two days of baiting with “Natrocell Pro”, scores of 66 and 76 on days 15 and 16 respectively, was slightly less than that seen during the pre-treatment census. This was probably caused by a substantial fall of snow. However, there was a very rapid and marked decline in track score throughout the first week of baiting and a low of 6 was the combined

score for the week-end period (days 12 – 14) at the end of the first week of baiting. The tracking score remained very low during the second week of bait application (Figure 7)

With bait takes, both from bait trays and burrows, having been negligible during the second week of baiting and with the maximum track score having been just 2 over the same period, it was decided to terminate the application of “Natrocell Pro” on day 29 (13.03.06). Thus, the period of application of “Natrocell Pro” was 14 days. All bait trays and bait were removed from the site on day 29 and bait bags were removed, as far as possible, from baited burrows the following day.

A total of 17 different non-target bird species was present at the site throughout the “Natrocell Pro” treatment (Appendix 10). The most numerous of these were Mallard duck (*Anas platyrhynchos*) and Canada goose (*Branta canadensis*), both of which frequented the large pond near the farm buildings. Other species were present in much lower numbers. Four cats were also present at the site. These occupied some of the treated buildings and were frequently seen in the proximity of baiting points. No harm was found to have come to any non-target animal during the “Natrocell Pro” treatment.

7.5 Post-treatment Census

The post-treatment census was carried out in exactly the same way as the pre-treatment census and from the same bait points (Figure 1). The recording of tracking activity also continued throughout the post-treatment census period (Figure 2).

The total bait take was 1.15 kg during the 4-day post-treatment census period, with a maximum take of 0.34 kg on the third day (18.03.06) (Table 1). The highest total tracking score, 12, on one day of post-treatment was also on day 32 (16.03.06) and the total track score for the four days was 35. Census bait trays were removed from the site on day 36 (20.03.06).

The full data set from the post-treatment census period, with information from individual bait points and tracking patches, is provided in Appendix 11 (census baiting) and Appendix 12 (tracking patches).

7.6 Treatment Efficacy at Crickett Farm

Track scores throughout the treatment are presented graphically in Figure 7, and census bait consumption and rodenticide bait consumption are presented graphically in Figure 6, both in terms of total weight of bait consumed and in terms of the number of bait points that had active bait take. The summary census data for the trial are presented in Table 1.

Table 1. Summary Census Data

Pre-treatment census				Post-treatment census			
date	census bait		track score	date	census bait		track score
	weight of bait eaten (g)	no. of points with take			weight of bait eaten (g)	no. of points with take	
13-Feb	1207	34	60	16-Mar	208	7	12
14-Feb	1627	34	73	17-Mar	329	7	5
15-Feb	1365	36	82	18-Mar	337	9	10
16-Feb	1914	32	80	19-Mar	278	5	8
totals	6113	136	295	totals	1152	28	35

The basis for calculations of the efficacy of the treatment is a comparison between equivalent information obtained in the pre- and post-treatment census periods (Anon., 2000), viz.:

$$\% \text{ efficacy} = \frac{\text{pre-treatment activity} - \text{post-treatment activity}}{\text{pre-treatment activity}} * 100$$

Guidelines from the UK Pesticides Safety Directorate (Anon., 2000) suggest that the total amount of census bait consumed provides an index of population size. Similar recommendations for the evaluation are emerging from the European Commission, although these guidelines are not yet formally adopted. If the statistic of total census bait take is used for efficacy assessment of the “Natrocell Pro” treatment at Crickett Farm, an estimate of 81.2% efficacy is obtained. A similar calculation can be made using the total tracking score as an index of pre- and post-treatment rat activity. An estimate of treatment efficacy of 88.1% efficacy is obtained by this method.

7.7 Prevailing Weather Conditions

The recordings of the prevailing weather conditions during the treatment period are presented in Appendix 13. The weather was extremely variable during the trial, with maximum daytime temperatures ranging from 0°C to 12°C. There were two falls of snow during the trial, the first on day 15 (27.02.06) and the second on day 28 (12.03.06). However, mild weather quickly followed the snowfalls and there was no long period of snow cover. The weather did not adversely affect the outcome of the treatment.

8. DISCUSSION

The amount of “Natrocell Pro” taken on the first day of the baiting treatment (1.04 kg) was only slightly less than the amount of whole wheat census bait consumed by the rat infestation on the first day of the pre-treatment census (1.21 kg). This observation indicated that the rat infestation at Crickett Farm found the “Natrocell Pro” formulation to be attractive. In addition to the quantity of the formulation taken from the bait trays an additional 1.15 kg was estimated to have been eaten in the burrows. The acceptance of rodenticide baits by rodent infestations are affected by several factors and these include the abundance, distribution and quality of alternative natural foods, the palatability of the rodenticide formulation, the skill of the operator in the placement of the rodenticide bait, the nature of any apparatus, such as bait trays and boxes, used for bait presentation and any learned behavioural responses of the infestation as a result of previous feeding experiences.

In the case of the “Natrocell Pro” treatment at Crickett Farm it is apparent that the above factors resulted in an excellent level of consumption of the test formulation. The alternative food for rats at Crickett Farm was a large stock of silage maize held in an outdoor clamp in the yard outside the main barn (Plate 6) and an open pile of animal feed pellets in the same barn (Plate 7). Of course, food was also available to rats where they had access to animal feed put out for the cows and calves in the main barn. However, much of this latter food was consumed quickly by the stock and it did not remain available for an extended period. Significant consumption of bait took place only over the first two or three days of the treatment and this indicates the relatively rapid effect of the rodenticide active substance. A similar pattern of bait consumption is seen in laboratory no-choice tests (Hoyer, 2002 a, b; Morgan, 2003b; Morgan and Eason, 2003).

Tracking activity during the pre-treatment census period and during the first days of the baiting programme were in close agreement (Figure 7). There was, however, a significant decline in tracking activity at the end of the first week of baiting such that the treatment was apparently completed within a week. Broadly similar assessments of treatment efficacy were made using census bait (81.2%) and tracking patch (88.1%) data and this provides confidence in the accuracy of these estimates. Although complete control was not achieved, the estimated level of 80-90% mortality compares very favourably with that achieved by other non-anticoagulant rodenticides. Two such compounds currently widely used in the European Union are zinc phosphide and calciferol (Buckle, 1994). A series of six carefully conducted field trials of 2.5% zinc phosphide, used after a period of five days pre-baiting, achieved an average of 79.5% mortality (Rennison, 1976). Similarly, a trial of calciferol was undertaken, with a 21-day period of pre-baiting, which resulted in an estimated efficacy of 67% (Quy *et al.*, 1995).

It was somewhat surprising to find that bait uptake and track score was virtually zero during the second week of baiting with “Natrocell Pro” but that, after the lag period, both track score and post-treatment census bait consumption were recorded, although these were limited. However, a possible explanation is to be found for this in the disposition of alternative rodent food at the site. One side of the large bay that held the silage maize was constructed from galvanised steel sheeting mounted on a wooden frame (Plate 6). The rats were able to harbour in this hollow construction and to enter the silage maize clamp directly to feed, without coming to the exterior at all. Similarly, in the main barn, a flat store of feed pellets was constructed with sides made from plywood, supported by straw bales and a large pile of logs. Rats harboured among the bales and logs, could burrow through the plywood and obtain direct access to the store of feed pellets (Plate 7). Baiting rats at these two locations on the farm was extremely difficult and it was not surprising therefore that post-treatment track score and census bait takes occurred in these two areas. It is probable that rats, whose home ranges had been restricted by social interaction while the rat infestation was undisturbed, extended their ranges after a large part of

the infestation had been removed, and this may have accounted for the increase in track score and census bait take during the post-treatment period.

However, notwithstanding these baiting difficulties, the “Natrocell Pro” baiting treatment achieved a very satisfactory level of control of rats at the site, between 81.2 and 88.1%, after a period of 14-days of baiting.

Plate 6. The silage maize clamp. The right side partition was constructed from zinc sheets on a hollow wooden frame. Rats occupied the interior of the frame and could enter the maize clamp directly through holes at the base without coming to the outside.



Plate 7. The animal feed store with plywood sides supported by straw bales and logs. Rats harboured in the bales and logs and had direct access to the back of the animal feed through the plywood sides.



“Natrocell Pro” is reported to have a high degree of safety to non-target animals (Morgan, 2003b-g) and no apparent harm came to any of the non-target animals present at the site during the treatment.

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