

Eradication of Lice in Cattle

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Nafstad O, Grønstøl H: Eradication of lice in cattle. Acta vet. scand. 2001, 42, 81-89 – The purpose of this field study was to develop and evaluate eradication as a strategy to control lice in cattle. Thirty-three herds of cattle were selected and observed during a period of two and a half years. Before eradication, biting lice (*Damalinia bovis*) were present in 94% of the herds and 27% of the animals. Sucking lice (*Linognathus vituli*) were present in 42% of the herds and 5% of the animals. These levels were very similar to those reported from other countries in Northern Europe. The eradication strategy was successful in 28 of 33 herds, but lice were still present in 5 herds 3 to 6 months after treatment. Biting lice were present in all these 5 herds, sucking lice were present in 3 herds. During the next 12 months, nine of the 28 herds were reinfected with lice. Six herds were reinfected with just biting lice, 2 herds with just sucking lice and one herd was reinfected with both. There was no significant difference between the 2 louse species regarding the risk of unsuccessful eradication or reinfection. The only significant risk factor for reinfection was either purchase of livestock or use of common pasture, combined with failure in pre-treatment of newly introduced animals.

lice; cattle; Damalinia bovis; Linognathus vituli; eradication strategy.

Introduction

Pediculosis in cattle occurs throughout the world, and is more common in cattle than in any other domestic animal (Urquhart *et al.* 1987). Two species of lice are endemic in Norwegian cattle, biting lice (*Damalinia (Bovicola) bovis* (Linnaeus 1758)) and sucking lice (*Linognathus vituli* (Linnaeus 1758)). Cattle lice cause irritation and restlessness, but there are conflicting opinions concerning their economic effects on livestock production. Fadok (1984) and Loomis (1986) maintained that lice can have a significant effect on milk production and weight gain. Gibney *et al.* (1985), Nickel (1971) and Scharff (1962) found a significant effect on weight gain. However, Chalmers & Charleston (1980 a) found no significant difference in weight gain or haematocrit levels between louse-infected and louse-free cattle. Other authors have also not found significant effects on growth rate (Kettle 1974, Cummins & Tweedle

1977, Cummins & Graham 1982). In recent years, hide damage caused by lice has been increasingly recognised as a significant effect of lice infestations (Bugby *et al.* 1990, Webster & Bugby 1990). The damage is described as areas of grain loss up to 3 mm diameter that are seen on dyed crust leather (Bugby *et al.* 1990).

Historically, lice control has been obtained through the use of various insecticides (Drummond *et al.* 1986, Hiepe 1988, Losson 1990, Wall & Shearer 1997), but toxicological problems, the environmental impact and residual effects have limited the practical use of topical insecticides. Different types of pyrethroids and new avermectin derivatives without residual problems are at present recommended for dairy cattle in lactation.

Louse infestations usually pass unnoticed until high numbers of lice occur on certain body regions or on the tail. Consequently, animals may

not be treated at all or only treated in the late winter when the louse population has increased and possible economic consequences are already present. If the farmers are aware of the louse problem, they usually treat with insecticides to control lice during the late autumn, which is the time when the animals are housed after a period on pasture and the lice populations are still low (Scott 1988). In recent years new strategies for the control of ectoparasites have been developed (Hiepe 1988). Eradication is a well known method to control mange mite (*Sarcoptes scabiei* var. *suis* Mègnin 1880) in pig production (Ebbesen & Henriksen 1986). Eradication of cattle lice in a single herd based on organophosphorus insecticides has also been previously described (Anthony *et al.* 1963). Eradication is defined as the elimination of an infectious agent from the animals and their environment and the establishment of precautions to prevent reinfection (Alexander 1986).

The present study was part of a large field investigation that was conducted to evaluate the extent and impact of lice infestations in cattle and to determine the effectiveness and economic consequences of eradication as a control strategy. This paper presents the results of the clinical evaluation of the lice eradication programme and assess the effectiveness of eradication as a control strategy for lice in cattle.

Materials and methods

Design

Thirty-three dairy herds were observed over a period of two and a half years. The cohort was open and included all animals leaving or entering the herds at any time. All animals, except for bulls weighing more than 400 kg l.w. kept in boxes, were examined 3 times, in March 1994, in March 1995 and in March 1996. Between the first and the second examination, in the second third of 1994, the herds in the main group (28

herds) were treated against lice. The herds were divided into 2 groups. One group was treated with deltamethrin and the other group with flumethrin as the main medicament in the eradication programme. The survey in March 1994 recorded the situation in the herds before eradication. The surveys in March 1995 and in March 1996 represented the clinical evaluation of the eradication programme.

Five of the herds took part in a pilot study. These herds were examined for the first time in November 1993 and the eradication started immediately after the examination. The herds in the pilot group were followed for two and a half years after treatment, and examined using the same procedure as for the herds in the main group.

Selection of herds

The herds were selected by the District Veterinary Officers in 2 counties in the South East of Norway (Akershus and Østfold). The 33 dairy herds were all based on Norwegian Red Cattle (NRF), but some of the herds included a few beef cattle. The selection criteria were:

- No registered lice problems and no systematic control of lice in the year preceding the commencement of the study.
- No signs of ringworm.
- The herd had to be member of the Dairy Cow Recording System (Husdyrkontrollen).

The number of lactating cows in the herds varied from 8 to 50. The total number of animals in all age classes varied from 22 to 128 recorded at the examination time in March 1994.

Eradication treatment scheme

The eradication programme was conducted according to the following treatment scheme:

- 1) All cattle were dosed twice with deltamethrin (Coopersect[®] vet) or flumethrin (Bayticol[®] vet) on day 1 and day 21 (2 mg/kg pour-on flumethrin or 100 mg/animal pour-on del-

tamethrin). These doses corresponded to the recommended doses for these preparations in the Norwegian market. The herds were randomised into 2 groups for comparison of flumethrin and deltamethrin. It was recommended that all animals should be clipped before treatment.

- 2) The barn was mechanically cleaned and subsequently sprayed with a 0.4% solution of heptenophos (Ragadan® vet).
- 3) Precautions were established to eliminate the risk of reinfections. The basic principles were the pre-treatment of all introduced animals and the use of special clothes and boots for visitors.
- 4) All animals introduced to the herds and animals in direct contact with those, were treated on day 1 and day 21.

In the main group of 28 herds, the eradication was performed between September and December 1994.

Examination procedure

The examinations of the herds were performed according to standard clinical examination developed for this study. All animals in the herds were inspected except for bulls over 400 kg l.w. kept in boxes. The examination was undertaken using a fine-toothed comb and a halogen lamp. The predilection sites of lice, namely the neck, shoulders, dewlap, rump and tail were examined closely. The differentiation between *D. bovis* and *L. vituli* was made on the colour and body shape of the lice (Wall & Shearer 1997). The diagnosis of pediculosis was based on the identification of one or more lice on an animal.

Registration of management and risk factors

A questionnaire recording the management factors, experience with the eradication programme and execution of the eradication and the precautions taken was completed with the farmer during all examination visits to a herd.

Table 1. Prevalence of lice in 28 Norwegian dairy herds.

	Biting lice <i>D. bovis</i>	Sucking lice <i>L. vituli</i>
Number of herds infected	27	11
Prevalence of herds infected	0.96	0.39
Prevalence of animals with lice	0.27	0.05

The risk factor «purchase of livestock» was defined as purchase of at least one animal in the period after eradication. The risk factor «use of common pasture» was defined as use of pasture together with at least one other herd in the same period. The risk factor «failure in precautions for livestock or animal from common pasture» was defined as at least one deviation from the recommended treatment procedures. The risk factor «failure in the precautions for persons» was defined as at least one visit to the herd without using the herd's special clothes and boots by persons who had had contact with other cattle. The analysis of risk factors was based on herds with success in the eradication programme and were free of lice 3 to 6 months after eradication. The results from both the pilot group and the main group were used in the analysis.

Statistical methods

All analyses were performed at herd level. The comparisons of different preparations, the effect of eradication and risk of reinfections with the two lice species and the effect of different risk factors were undertaken using EpiInfo (Dean et al. 1996).

Results

Prevalence of lice before eradication

The situation before eradication is described in Table 1. *D. bovis* was present in 27 of the herds

Table 2. Result from a pilot study including 5 herds that were treated to eradicate lice in December 1993.

Herd	Size (no. dairy cows)	Herd characteristic	Lice infestations before medication	Medicament	Lice present after medication		
					March 1994	March 1995	March 1996
A	25	Open herd: Purchasing livestock Using common pasture	<i>D. bovis</i> <i>L. vituli</i>	Flumethrin	No lice	No lice	No lice
B	16	Closed herd	<i>D. bovis</i>	Deltamethrin	No lice	No lice	No lice
C	10	Open herd: Using common pasture	<i>D. bovis</i>	Deltamethrin	No lice	<i>D. bovis</i>	<i>D. bovis</i>
D	20	Open herd: Purchasing livestock	<i>L. vituli</i>	Deltamethrin	No lice	No lice	No lice
E	40	Open herd: Purchasing livestock	<i>D. bovis</i> <i>L. vituli</i>	Flumethrin	No lice	No lice	<i>D. bovis</i> <i>L. vituli</i>

examined in March 1994 and in 4 herds in the pilot group examined in December 1993. *L. vituli* was present in 11 of the herds examined in March 1994 and in 3 herds examined in December 1993. Both *D. bovis* and *L. vituli* were present in 10 herds in the main group in March and in 2 herds in the pilot group in December. On the individual level, *D. bovis* was present in 27% of the animals and *L. vituli* in 5% of the animals. Short nosed sucking lice (*Haematopinus eurytenuis* (Denny 1842)) and little blue

cattle lice (*Solenopotes capilatus* Enderlein 1904) were not present, and these 2 species are not endemic in Norway (Gjerde 1994).

Results from the pilot study

Five herds took part in a pilot study. These herds were examined and lice eradication carried out in December 1993, and these herds were followed to March 1996. Herd characteristics, louse status before treatment and results of the eradication are described in Table 2.

Table 3. Results of eradication of lice in 28 dairy herds.

Examination time, months after medication	Number of herds examined	Free	<i>D. bovis</i> present	<i>L. vituli</i> present
3-6	28	23	5	3
15-18	23	15	6	3

Table 4. The effect of risk factors on reinfection lice after eradication*.

Risk factor	Number of herds (n=28)	Result 15-18 months after the eradication		Relative risk	p-value Fisher's exact test One tailed
		Free	Lice Present		
Purchase of livestock or use of common pasture	20	12	8	1.41 (0.93 - 2.13)	0.17
Identified failure in precautions for livestock	9	2	7	5.25 (1.44 - 19.11)	0.005
Identified failure in precautions for persons	28	19	9	-	-

*The analysis was based on herds which succeeded with the eradication from both the pilot group and the main group.

Effect of the eradication in the main group of herds

In March 1995, 3 to 6 months after eradication, lice were present in 5 herds. *D. bovis* was present in all 5 herds, and *L. vituli* was present in 3 of the 5 herds (Table 3). In all infected herds only 1 or 2 animals had pediculosis. Shortcomings in the eradication programme were identified in 3 of the herds that had lice after treatment. The most common error was failing to treat one or a few animals at one or both of the treatments. Only 10 farmers had clipped all animals in the herd before treatment.

The 23 herds in the main group that succeeded in eradicating lice were re-examined after 12 months to evaluate the risk of reinfection. In March 1996, 15-18 months after the eradication

programme, lice were present in a total of 8 of these herds. Six herds were reinfected with *D. bovis*, while 3 herds were reinfected with *L. vituli* (Table 3). Fifteen herds in the main group were free of pediculosis at the final examination.

Risk factors and reinfection

The numbers of herds where risk factors were present and the relative risk of reinfection are presented with their confidence intervals and p-values in Table 4. Open herds where sufficient precautions were not taken had a significantly higher risk of reinfection (RR: 5.25). None of the herds had completely satisfactory precautions for visitors.

Table 5. Effect of deltamethrin and flumethrin as main treatment in eradication of lice in 33 dairy herds.

Medicament	No. herds	3-6 months after the eradications		15-18 months after the eradications	
		Free	Lice present	Free	Lice present
Deltamethrin	17	14	3	9	3+5
Flumethrin	16	14	2	10	2+4

Comparison of deltamethrin and flumethrin

The difference between deltamethrin and flumethrin was assessed on the basis of the surveys in March 1995 and 1996. The results are presented in Table 5. There was no significant difference between the 2 groups at any examination time.

Discussion

The results of the survey in March 1994 indicated the same level of lice infestation in cattle in Norway as in other countries in Northern Europe. *Christensson et al.* (1994) found lice in 25 out of 27 farms examined in survey conducted in Sweden and in 29% of the examined animals. Surveys from Scotland and The Netherlands indicated a similar level (*Titchener* 1983, *Hendriks* 1992). All these results indicate that lice are a significant and underestimated problem in untreated herds.

In the present study, the eradication programme succeeded in 28 of 33 herds, assessed 3 to 6 months after treatment. *D. bovis* was present in all the 5 affected herds and *L. vituli* in 3 of the affected herds. These results did not imply any significant difference between the 2 species. The eradication programme was not carried out correctly in 3 of the 5 herds that did not succeed in eradicating lice. The most critical mistake was to omit animals at one or both treatment times. This mistake was not detected in any of the herds that were free of lice 3 to 6 months after eradication. The result indicated that eradication can be an appropriate strategy for the control of lice in cattle, but the programme has to be carried out according to the recommended procedures.

The 28 herds (23 from the main group and 5 from the pilot group) that were free of lice at the examination 3 to 6 months after eradication were examined 12 months later. Lice were present in 9 of the herds at this second examination. *D. bovis* was present as the only species in

6 of the herds, *L. vituli* was present as the only species in 2 herds, and a mixed infection was present in one herd. The results did not indicate any difference between the 2 lice species in risk of unsuccessful eradication or reinfection.

Anthony et al. (1963) accomplished an eradication of lice in a research herd and followed up the herd for 3 years. The eradication programme was based on 2 treatments with the organophosphorus insecticide malathion with a 14-day interval. All newly introduced animals were treated, placed in quarantine for 14 days, and given a second treatment at the end of this period. This eradication programme was a success for *D. bovis* and *L. vituli*, but a small population of *H. eurysternus* survived. The result of this investigation for the 2 species present under Norwegian conditions supports the conclusion of the present study.

Eradication can be defined as an absolute elimination of the infectious agent from an area or a herd unit (*Hiepe* 1988). Different strategies can be used according to the nature of the infectious agent. The most important strategies are depopulation, strategic culling, vaccination and systematic medication, or combination of these strategies. A completely effective medicament and control for reservoirs of the infectious agent are necessary assumptions for the use of systematic medication as an eradication strategy. Eradication as a control strategy has some important advantages compared with other treatment strategies. The animals are constantly free of the infectious agent after treatment, the total consumption of medicaments decreases, and the risk of the development of resistance is reduced. Lice are highly host specific, obligate and permanent ectoparasites (*Wall & Shearer* 1997). Cattle lice are unable to survive for more than a few days off their host (*Matthysse* 1946, *Wall & Shearer* 1997). These features of the biology of the parasites are the basis for develop-

ing an eradication method based on systematic medication.

The lice population changes during the year. The population increases in the winter and reaches its highest level in the late winter and early spring (Scharff 1962, Chalmers & Charleston 1980 b, Geden *et al.* 1990). Both eradication time and examination times were selected based on this seasonal variation. The eradications were carried out in the autumn, when the louse population was low. This treatment time would be expected to increase the possibility for a successful eradication. The examination time was selected to maximise the possibility to detect unsuccessful eradications or reinfections.

Clipping decreases the lice population (Allen & Dicke 1952, Nafstad 1998 b). Based on this observation, clipping was included in the eradication program. This depopulation of lice before the insecticide treatment was expected to increase the possibility to success. However, only 10 farmers clipped all animals in the herd before treatment, and there was no significant difference between clipped and unclipped herds. This result supported the recorded effect of the pyrethroid pour-on medicaments (Titchener 1985, Liebisch 1986), and suggested that clipping was not a necessary part of an eradication programme.

The result 3 to 6 months after eradication gave an indication of the success of the eradication programme, and the result 15 to 18 months after eradication indicated the risk of reinfection. These findings confirmed that direct animal to animal contact is the most important transfer mechanism (Loomis 1986). Herds purchasing livestock, or grazing on common pasture with other herds without consistent pre-treatment of introduced animals, had a significantly higher risk of reinfection. Open herds that use pre-treatment did not have a significantly higher risk of reinfection than closed

herds, as assessed based on the number of herds included in the present study. These results suggested that eradication can be an appropriate strategy for lice control in open herds, if pre-treatments are performed correctly. Calves and young animals are the age groups most usually purchased and also the age groups with the highest prevalence of lice (Chalmers & Charleston 1980 c, Geden *et al.* 1990, Nafstad 1998 a). Purchase of such animals increased the risk of reinfection in herds not using pre-treatments. Short-comings in the use of precautions for persons were identified in all herds. If transfer of lice on personnel was a significant risk factor, it may have masked the effect of other risk factors. That did not happen and the result suggested that transfer of lice on humans is not an important route of transfer of lice between herds.

Pyrethroids are effective insecticides, and both deltamethrin and flumethrin have been shown to be nearly 100% effective against *D. bovis* and *L. vituli* in controlled studies (Titchener 1985, Liebisch 1986). Many pyrethroids are lipophilic which assists the development of pour-on formulations with good distribution (Losson 1990). Natural pyrethrins are quickly degraded, while synthetic pyrethroids such as flumethrin and deltamethrin have greater stability and a relatively long period of action (Zerba 1988), but they do not affect all developmental stages of the louse life cycle. The eradication programme with two treatments within an interval of 21 days was based on these pharmaceutical properties combined with knowledge of the louse life cycle. Both *D. bovis* and *L. vituli* have an entire egg-to-adult life cycle of about 4 weeks under normal circumstances (Matthysse 1946, Landcaster 1957, Wall & Shearer 1997). The present study did not detect any difference in effects between deltamethrin and flumethrin.

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Sammenheng

Sanering av lus hos storfe.

Sanering som behandlingsstrategi mot lus (*Damalinia bovis*, *Linognathus vituli*) hos storfe ble utprøvd i et feltforsøk som omfattet 33 mjølkeproduksjonsbesetninger. Besetningene ble fulgt gjennom 30 måneder, fra 1.1.94 til 30.6.97, og sanert i perioden 9 til 12 måneder etter forsøksstart. Alle besetninger ble undersøkt klinisk for lus i mars hvert år, et tidspunkt som antas å representerer et maksimalnivå for lusepopulasjonen. Før sanering ble pelslus (*D. bovis*) påvist i 31 (94%) besetninger og hos 27% av dyra.

Blodlus (*L. vituli*) ble påvist i 14 (42%) besetninger og hos 5% av dyra. Saneringsprogrammet var basert på to behandlinger med 21 dagers mellomrom av alle dyr i besetningen med et pyretroidbasert pour-on-preparat. Besetningene ble delt i to grupper, en gruppe ble behandlet med flumethrin (Bayticol® vet), den andre gruppe ble behandlet med deltamethrin (Coopersect® vet). Husdyrrommene ble vasket og oversprøytet med en 0,4 % oppløsning med heptenphos (Ragadan® vet) i forbindelse med saneringen. Alle dyr som ble introdusert i besetningen eller hadde vært i direkte kontakt med andre besetninger i perioden etter sanering skulle umiddelbart behandles etter samme mønster som ved sanering. Saneringen var vellykket i 28 av 33 besetninger evaluert ved klinisk undersøkelse av alle dyr i besetningen 3-6 måneder etter sanering (mars 1995). Pelslus (*D. bovis*) ble påvist i alle fem besetninger som ikke hadde lyktes, blodlus (*L. vituli*) ble påvist i tre av dem. Det var ingen forskjell i resultat mellom de to ulike pyretroidpreparatene. Ved klinisk undersøkelse av alle dyr i besetningene 15-18 måneder etter sanering var 19 besetninger fortsatt fri for lus. Seks besetninger var reinfisert bare med pelslus, to besetninger med bare blodlus og en besetning med begge arter. Introduksjon av livdyr eller bruk av fellesbeite uten konsekvent gjennomføring av introduksjonsbehandling av dyra var eneste signifikante risikofaktor.

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