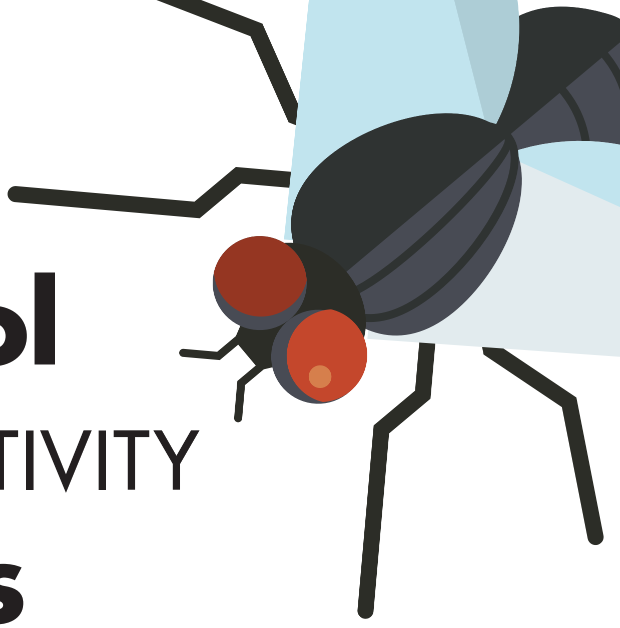

# Horn Fly Control
## TO INCREASE PRODUCTIVITY
# in Dairy Heifers

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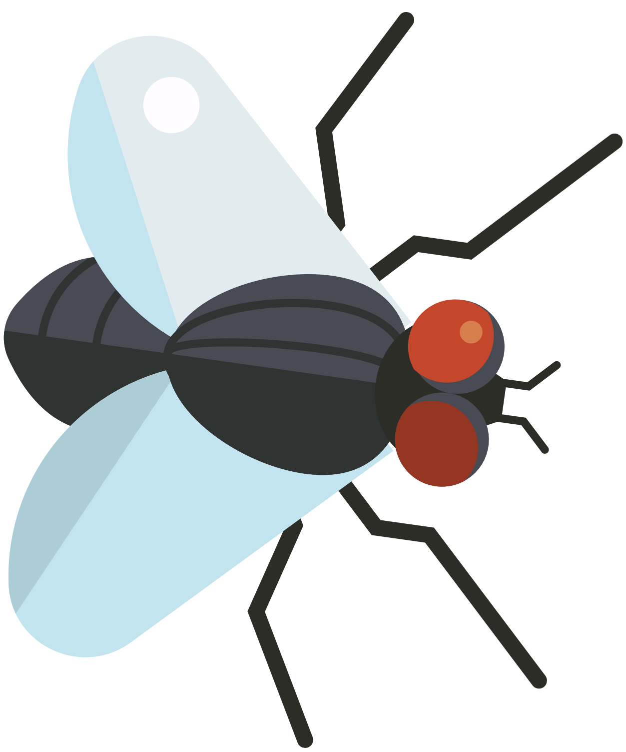
This bulletin discusses the role of the horn fly (*Haematobia irritans*) in the initiation and spread of staphylococcal mastitis among dairy heifers. The publication goes on to discuss the benefits of horn fly control and the ways that managing fly populations affect farm profitability. The horn fly is an irritant to livestock, and in response to the incessant painful biting and bloodsucking, cattle expend a great deal of energy in defensive behavior. This expenditure results in elevated heart and respiratory rates, reduced grazing time, decreased feeding efficiency and rate of gain, and reduced milk production. Additionally, the horn fly can serve as a disease vector, initiating and spreading infections like mastitis in dairy heifers. As such, the horn fly is one of the most economically important pests of cattle worldwide. In the US, $700 million to $1 billion in losses are attributed to the horn fly each year, with an additional $60 million spent annually on parasite control. Herd surveys have revealed that the prevalence of mastitis in heifers is markedly lower in dairy herds using some form of fly control compared with herds without a pest control program. The horn fly has a demonstrated role in the development of teat lesions on heifers that develop into chronic *Staphylococcus aureus* mastitis, which is then spread among heifers by these same insect vectors. Such infections, if left untreated, negatively affect the development of milk-producing tissues in the udder, resulting in less than optimal yield and quality during the first and subsequent lactations. The implementation of horn fly control measures, such as aerosols, bait, strips, foggers, dust bags, traps, oilers, ear tags, pour-ons, natural predators, and insect growth regulators is instrumental in reducing the new infection rate, while existing mastitis cases can be eliminated with antibiotic therapy. Such management practices will promote animal health and wellbeing, ensure that heifers calve with low somatic cell counts (SCC), and encourage the potential for maximum milk yield, thereby enhancing producer profits.



UGA extension

# Recent History of Mastitis Control

For the past 50 years, the five-point plan for mastitis control has served as the framework used by dairymen to prevent and treat intramammary infections (IMI) in their dairy cows. This plan includes 1) teat dipping, 2) dry cow therapy, 3) adequate milking machine function, 4) proper milking hygiene, and 5) treatment of clinical cases. Over the years, additions have been added to this basic plan, such as proper nutrition, vaccination, record keeping, breeding, etc. However, one potential mastitis management practice that has been overlooked is fly control, and with the proposed SCC legal limit of 400,000/mL looming in the very near future, and milk co-ops demanding bulk tank SCC maximum closer to 200,000/mL, every attempt to reduce animal stress and the development of new IMI is warranted, especially during the hot summer months when fly populations are at their peak.

Historically, the major association between flies and IMI has been with the development of summer mastitis, in which the biting fly, *Hydrotoea irritans*, is the proven vector. Summer mastitis is an isolated seasonal problem that occurs primarily in July, August, and September in heifers and dry cows of northern Europe, and may be controlled by insecticidal sprays. In the United States, fly control is used to reduce these insect pests on farm premises, and subsequently reduce animal stress, but producers have not fully considered or embraced its application as an adjunct management practice for preventing new cases of mastitis and reducing SCC in dairy heifers when they calve.

Replacement heifers, whether they are raised on the farm, purchased from other dairies, or raised by contract heifer growers, are critical to herd productivity because they represent the future milking and breeding stock in all dairy operations. The goal should be to provide an environment for heifers to develop full lactation potential at the desired age with minimal expense. Animal health and wellbeing play vital roles in achieving this potential, and one disease that can influence future productivity is mastitis, a disease that can be initiated and spread by horn flies.

# Horn Fly as a General Livestock Pest and Disease Vector

The horn fly (*Haematobia irritans*), as the name suggests, is an irritating bloodsucker and general insect pest to all livestock species, including dairy cattle. Its incessant biting, bloodsucking, and associated stress to its host result in much energy expended in defensive behavior on the part of dairy cattle, such as kicking, head throwing, and stomping in attempts to dislodge the flies. The energy expended in these efforts results in elevated heart and respiration rates, reduced grazing time, decreased feed efficiency and rate of gain, reduced milk production, and lower weaning weights. As a consequence of these changes, the producer experiences economic losses. Annual losses due to horn flies in the United States range from $700 million to $1 billion or more, plus an additional $60 million in parasite control. The greatest losses involve growing animals, such as dairy heifers, in which the horn fly serves as a disease vector in the transmission of granular dermatitis, staphylococcal mastitis, and possibly, anaplasmosis.

The fly's life cycle from egg to adult is 10 to 14 days. Horn fly adults are typically 3 to 5 millimeters in length and live for 2 to 4 weeks. During that time, the flies feed exclusively on the blood of livestock, consuming over 20 meals per day. Females leave the animal's body only briefly to lay their eggs in fresh manure, depositing 500 eggs per fly. Eggs hatch into larvae, which consume manure for 1 to 2 weeks, then pupate in the adjacent soil, emerging as adult flies, and the cycle continues. Because the horn fly is an important vector in the initiation and spread of staphylococcal IMI, its control is instrumental in decreasing exposure of livestock to mastitis-causing bacteria and reducing the development of new infections. Successful control will lead to improvements in mammary gland health as well as animal wellbeing.

# Why Udder Health in Dairy Heifers Is Important

Mammary development in heifers begins when animals are in the embryonic stage and continues through the fetal stage. By the time a heifer is born, she has the basic mammary gland structure, including the teat canal, teat and gland cisterns, milk ducts, and rudimentary alveoli (end buds), along with all the supporting ligaments and vascular and nervous components. Development continues through puberty and gestation, and by the time the heifer calves, the basic mammary structure that she was born with is producing copious quantities of colostrum followed by milk. Because her future milk production is dependent on udder growth and development during her first pregnancy, it is vital that mammary tissue develop in an optimum fashion; the major deterrent to optimum milk-producing potential is mastitis.

Unfortunately, young dairy heifers are often regarded as uninfected, and mastitis is not noticed until freshening or at the first clinical flare-up during early lactation. It must be kept in mind that these animals represent the future milking herd, and need an udder health program as do older lactating and dry cows. In some herds, especially those with excessive exposure to horn flies, greater than 75 percent of breeding age heifers (12 to 15 months of age and older) have subclinical mastitis, and 20 to 30 percent of animals will be infected with *Staphylococcus aureus* with SCC in mammary secretions exceeding $10 \times 10^6$/mL. However, few animals will exhibit clinical symptoms, such as swollen quarters or abnormal secretions containing clots and flakes; most will appear perfectly normal but will harbor subclinical infections.

Heifers are exposed to mastitis-causing bacteria at a very young age. Shortly after birth, bacteria, especially the staphylococci, colonize teat surfaces, and *S. aureus* has been isolated as early as 5 days of age (Roberson *et al.*, 1994). Such colonizations most likely persist into the prepubertal stage, and by the time they are of breeding age, many heifers have well-established staphylococcal IMI that are carried throughout pregnancy and into early lactation. An animal may carry an IMI for a year or more before it is diagnosed with mastitis at freshening (Boddie *et al.*, 1987). Thus, if heifers are bred to calve at 2 to 2.5 years of age, this period of time between calfhood and freshening (2 to 2.5 years) represents one-quarter to one-half of their productive lifetime (about 3.5 to 4 lactations), during which there is no mastitis control program, potentially leading to a decrease in milk yield and an increase in SCC during their first lactation. Again, heifers represent the future milking herd, are susceptible to mastitis, and need an udder health program just as older lactating and dry cows do.

# The Infection Process and the Mammary Tissue Response to Infection

There are about a dozen or so species of bacteria that have been isolated from heifer mammary glands, but the vast majority are the staphylococci and include *S. aureus* and the coagulase-negative staphylococcal (CNS) species such as *Staphylococcus chromogenes*, *Staphylococcus hyicus*, and *Staphylococcus simulans*. Very few environmental streptococci are isolated until approximately one-week prepartum, and these include *Streptococcus uberis* and *Streptococcus dysgalactiae*; coliform isolations are rare.

The question becomes “How do heifers get mastitis in the first place?” These animals are not exposed to IMI present in the lactating herd via the milking machine, and are usually not housed or pastured with nonlactating cows that may have IMI. Instead, staphylococci (*S. aureus* and the CNS) naturally colonize teat surfaces and teat canal keratin, which places them in an opportunistic position to gain access to the teat cistern, multipy in lacteal secretions, and eventually infect the developing mammary tissue. In addition, horn flies serve as vectors in the transmission of staphylococci to teat surfaces by establishing abcesses that become colonized by the bacteria (explained in detail below), again placing them in an opportunistic position, that is, in close proximity to the teat orifice to gain access to the interior of the udder.

As a result of these modes of infection, research has shown that in some herds, infection rates can be as high as 97 percent (Boddie *et al.*, 1987; Nickerson *et al.*, 1995; Trinidad *et al.*, 1990b). These same researchers also found that if bred heifers infected with *S. aureus* were left untreated, they produced 10 percent less milk in the first lactation than those receiving intramammary nonlactating cow therapy during gestation (Owens *et al.*, 1991; Trinidad *et al.*, 1990c). Other research has shown that *S. aureus* mastitis in heifers results in significant production losses during the first lactation, which carries over into the subsequent lactation, even if infected quarters are successfully treated in the first lactation (Woolford *et al.*, 1983).

Such *S. aureus* IMI are associated with pathological alterations to the developing mammary tissues and elevated SCC, which negatively affect milk production during the subsequent lacation (Trinidad *et al.*, 1990a). Typically, a heifer contracting a *S. aureus* IMI during gestation—and remains untreated—will calve with that same IMI and an elevated SCC, resulting in a 10 percent reduction in yield during her first lactation. That is the difference between a 20,000-lb and 22,000-lb first-calf heifer.

## Treatment of Existing Mastitis Cases

Because the greatest mammary gland development and growth of a dairy animal occurs during the first gestation, it is important to protect the heifer's udder from mastitis-causing bacteria to ensure maximum milk production during her first lactation. If mastitis is suspected, as evidenced by swollen quarters or teat lesions resulting from fly bites, then infected quarters should be treated with antibiotics. Treatment can be successfully performed using an approved nonlactating (dry cow) antibiotic product, and because at least two quarters are typically infected, it is recommended to treat all four quarters. The type of antibiotic used and the brand name are less important than the actual treatment, but it is best to treat prior to 30-days prepartum to avoid residues in milk at freshening. Greater than 90 percent of mastitis-causing staphylococci are generally killed by the drug preparations used, based on in-vitro sensitivity testing using zone diffusion analysis (Watts et al., 1995).

Prior to administering therapy, it is important to 1) sanitize the teat orifice with the alcohol pledgets provided with treatment syringes, 2) use the partial insertion technique when inserting the syringe cannula into the teat canal, and 3) dip teats in a germicide after infusion to kill any contaminating bacteria inadvertently placed at the teat orifice. Cure rates typically range from 90 to 100 percent, SCC are reduced 50 percent compared to untreated heifers, and subsequent milk production is increased 10 percent when they are treated during pregnancy (Owens *et al.*, 1991; Owens *et al.*, 1994; Trinidad *et al.*, 1990c). The treatment procedure can be performed when animals are restrained during pregnancy checks, in the course of hoof trimming, or when animals are transferred to the close-up lot (e.g., as they are processed through a chute or headlocks). Although antibiotic therapy is successful, use of dry cow therapy in heifers is regarded as off-label and requires veterinary oversite via a valid veterinarian-client-patient relationship (VCPR).

## Prevention: The Key to Mastitis Control

Antibiotic therapy is necessary to treat and cure existing IMI; however, the key to controlling this disease is to prevent it in the first place. Prevention can be attained through vaccination, use of teat seals, dietary supplementation, and lastly, horn fly control, which is the subject of this bulletin. Horn flies are typically seen on the backs and withers of heifers, and are easily identified by their small size, fighter-jet-like appearance, and heads pointing toward the ground (Figure 1). These pests not only annoy heifers by feasting on blood drawn from animals' backs, they also attack heifers' teats, which results in IMI. To obtain its

**Figure 1.** Horn flies on the back of a Holstein heifer. Note the preference for dark hair over white hair.

meal of blood, the horn fly injects its proboscis through the epidermis and into the underlying dermis through which blood capillaries flow, and sucks blood through the proboscis like a straw. The proboscis is similar to a hypodermic needle but is equipped with dozens of tiny barbs or prongs, which irritate the skin upon insertion or injection. In addition, bacteria colonizing the proboscis as well as those colonizing the fly's legs are placed on the teat skin surface at the site of injection, resulting in abcess formation. Because one teat may host 10 flies at a time, and assuming each fly bites approximately 20 times a day, it is not suprising to observe teat ends that are entirely covered with abscesses and scabs (Figure 2). Such abcesses harbor numerous staphylococci, and because they are located at the teat end, the bacteria are placed in an opportunistic position for gaining access to the teat orifice, colonizing and multiplying in teat canal keratin, and eventually progressing upward into the teat cistern, finally causing a true IMI.

Figure 2. Teat lesions resulting from the blood sucking activities of horn flies. Note the preponderance of scabs on the front teats, which are concentrated at the teat end, close to the point of bacterial entry at the teat orifice.

Horn flies preferentially attack front teats over rear teats, resulting in a greater prevalence of IMI in front quarters of heifers (Figure 2). In one study (Ryman *et al.*, 2013), the odds of diagnosing an IMI caused by any mastitis pathogen in front quarters were 5.1 times higher than the rear quarters. Similarly, the odds of *S. aureus* IMI diagnosed in front quarters were 3.9 times higher than rear quarters. The higher odds of diagnosing an IMI in front quarters was attributed to the role that the horn flies play in transmission of infection, specifically *S. aureus*, by preferentially drawing blood from front teats. The reason why horn flies prefer front teats is unclear; however, these flies are attracted to the navel area of the heifers, which is in close proximity to front teats. Also, the tail switch may be more effective in repelling flies from alighting on rear teats than front teats. In addition, front teats tend to be larger than rear teats in dairy heifers, providing a greater surface area from which to draw blood.

Teat skin condition is a good barometer for fly control (Figure 3). If heifers' teat scores are not healthy (Score 1), then a fly problem exists, and teat lesions (Scores 2 and 3) are associated with mastitis, and some form of control should be implemented. Bred heifers having teats with bite lesions and scabs caused by horn flies were found to exhibit a 70 percent frequency of IMI compared with a 40 percent frequency in heifers with normal teats free of lesions (Nickerson *et al.*, 1995). In fact, herds with fly control programs have healthier teats and less mastitis among their heifers.


Figure 3. A normal, healthy teat end, free of abrasions (Score 1) and increasing levels of teat-end damage due to horn flies (Scores 2 and 3).

The percentage of heifers with mastitis in herds with and without a fly control program in place was evaluated in a Louisiana field trial (Nickerson *et al.*, 1995; Figure 4). Methods of fly control were generally focused on adult lactating and dry cows and included the use of foggers, bait, pour-ons, dust, sprays, and ear tags. Compared with herds using no fly control, heifers in herds employing one or more of the fly control methods listed exhibited fewer environmental streptococcal IMI (3.7 vs. 20.7 percent), fewer CNS IMI (32.9 vs. 41.4 percent), fewer *S. aureus* IMI (5.6 vs. 55.2 percent), and fewer overall IMI (44.4 vs. 100 percent).

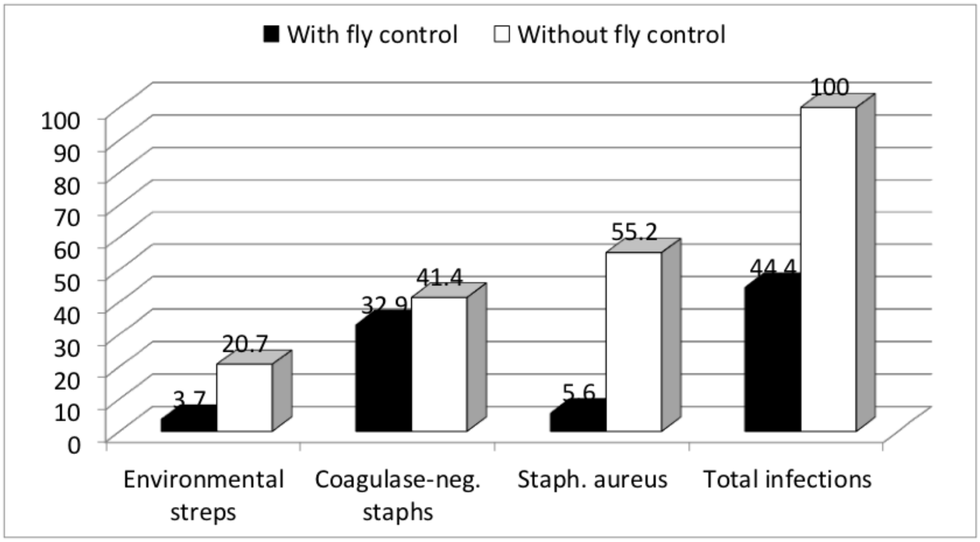



Figure 4. Percentages of heifers with mastitis (Y-axis) in herds with and without fly control.

It is noteworthy that there was an approximate tenfold increase in *S. aureus* IMI in herds without fly control compared with those using fly control. Thus, herds with some form of fly control have fewer mastitic heifers. The question becomes: How to prove that the horn fly is the vector in the initiation and spread of IMI among dairy heifers?

## Horn Fly As a Vector in the Initiation and Spread of Mastits Among Heifers

Through a series of DNA fingerprinting studies, it was demonstrated that horn flies transmit *S. aureus* among heifers, and that flies and teat scabs were sources of *S. aureus* IMI (Gillespie *et al.*, 1998; Owens *et al.*, 1998). For these studies, *S. aureus* isolated from horn flies, teat scabs, and mammary secretions were evaluated by DNA fingerprinting. Initially, horn flies were collected from the backs of heifers that were restrained in a squeeze chute, and then the flies were held in a feeding chamber. In the chamber, flies were fed a meal of bovine blood that had been innoculated with $10^6$ cfu/mL of *S. aureus* with a specific DNA fingerprint. After feeding for 12 hours, flies were harvested, frozen, and dissected to separate the head, body, and proboscis. Heads and body parts were each then homogenized in sterile saline, and 0.01 mL of the homogenate was plated onto bovine blood agar and incubated for 24 hours to demonstrate that flies had indeed consumed the innoculated blood by counting the numbers of *S. aureus* colony-forming units (cfu) present. A separate population of flies that was not allowed to feed on the blood was processed similarly as a control.

After 24 hours of incubation, plates of homogenates from the heads of flies fed *S. aureus* revealed cfu that were too numerous to count (TNTC), whereas those from controls revealed several cfu of nonhemolytic staphylococci but no *S. aureus*. Likewise, after 24 hours of incubation, plates of homogenates from bodies of flies fed *S. aureus* revealed cfu that were TNTC, whereas those from controls revealed numerous cfu of nonhemolytic staphylococci and only two *S. aureus* cfu. Several proboscises of flies fed *S. aureus* were placed directly onto the surface of bovine blood agar plates and incubated as above, and revealed an average of 12 *S. aureus* cfu in the surrounding media.

The *S. aureus* isolates from all body parts of flies fed innoculated blood were processed, and specific DNA fingerprint amplified DNA fragments were visualized by agarose gel electrophoresis and then analyzed (Gillespie *et al.*, 1998). The relationship among fingerprint patterns of *S. aureus* demonstrated that isolates from all body sites were identical to those of the *S. aureus* in the original blood meal. Thus, horn flies, after feeding, were successfully innoculated with the *S. aureus* identified by a specific DNA fingerprint.

The next step was to determine if these *S. aureus*-laden horn flies could serve as vectors in the initiation and spread of *S. aureus* IMI. After feeding on the *S. aureus* with the specific DNA fingerprint for 12 hours, flies were placed in 50-mL conical test tube "cages" secured to the front teats of heifers for a 24-hour period; both front quarters had been dignosed as uninfected. During this time, flies sucked blood from the underlying capillaries, and in the process, injected *S. aureus* into the wound, causing an abscess and subsequent scab formation, which provided a reservoir for IMI. Such IMI were caused by the same strain (DNA fingerprint) of *S. aureus* that flies were originally fed. Indeed, the relationship among fingerprint patterns of *S. aureus* demonstrated that isolates from mammary secretions were identical to those isolated from horn flies and teat scabs. Therefore, horn flies and teat scabs were identified as the sources of *S. aureus* IMI.

## Methods of Horn Fly Control

After horn flies were established as a vector in the initiation and spread of *S. aureus* IMI among heifers, the question became: "What could be done to control these insect pests?" The first method attempted was the use of tail tags impregnated with a repellent releasing slow-release pyrethrins placed just above the tail switch in the area of udder, where they could also reach the flanks and backs of animals (Nickerson *et al.*, 1997). For this study, 15 bred Jersey heifers were fitted with tail tags and 15 served as untreated controls. Prior to tag placement in early May (week -1), fly populations were about 170 flies per side, and by one week after placement, fly populations decreased by 66 percent (to about 65 flies per side) in treated heifers. Populations in controls remained above 150 throughout the trial (Figure 5). Maintaining the fly population to below 100 per side is believed to be adequate control to prevent the development of new IMI, and the tail tags were effective in that regard through the first 10 samplings. However, by mid-July (week 10), fly numbers per side exceeded 100 per side, and by early September (week 17), the use of tail tags had only decreased the fly population by 32 percent. The reason for this decrease in effectiveness was because tags began to fall off in late June, and by September, many were lost. Tags were not replaced.

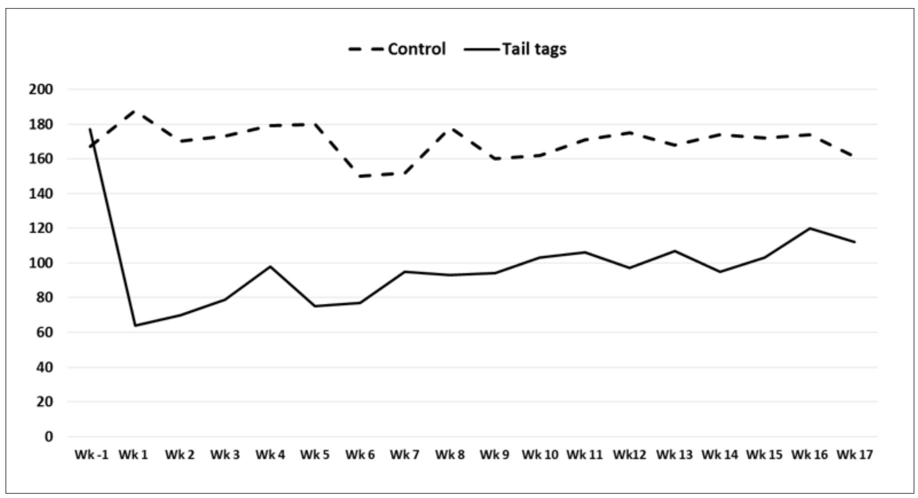



Figure 5. Use of tail tags to control horn fly numbers per side (Y-axis) in Control and Treated (tail tags) heifers.

For this study, the incidence of mastitis among treated and control heifers was monitored by recording the percentage increase in IMI above pretreatment levels over the trial. One week after placement (mid-May), an 8.6 percent increase in IMI was observed among treated heifers vs. a 17.2 percent increase in controls. This trend continued through mid June (with a 15 percent increase in treated heifers vs. a 52.4 percent increase in controls); however, by mid-July, the difference was 67.2 percent vs. 75.5 percent among treated and control heifers, respectively, because tail tags had begun to fall off and were less effective.

As an alternative control method, the trial tested a pour-on (five percent permethrin formulation with five percent piperonylbutoxide) administered at 3 mL per 100 lb of body weight, which was designed to control flies for eight weeks. However, to maintain fly numbers below 100 per side, the product had to be used every two to three weeks, which became labor intensive. In spite of this, the process has been shown to be effectve in not only reducing fly populations, but also in improving teat skin condition and reducing the prevalance of mastitis. For example, in one study, prior to implementation of a control program, the teats of 29 heifers were scored as follows: A score of 1 corresponded to healthy skin with no scabs; a score of 2 corresponded to older scabs that were darker and red-brown in color; and a score of 3 corresponded to fresh scabs that were bloody and dark red in color (Figure 3). When it was deemed necessary, based on fly population density, pour-on fly treatment (Ultra Boss®, Merck Animal Health, Summit, NJ) was initiated per label instructions and administered to all heifers every 14 to 21 days to minimize fly density and allow teats to heal. Before fly control, right and left front teats exhibited higher mean teat scores (2.4 and 2.4, respectively) compared to mean scores of right and left rear teats (1.4 and 1.4, respectively), demonstrating that front teat condition was poorer than rear teat condition (Figure 6). Impaired teat skin condition was associated with IMI and increased SCC. During peak fly season, SCC were numerically greater among front quarters (3,493,000/mL) compared to rear quarters (2,583,000/mL).

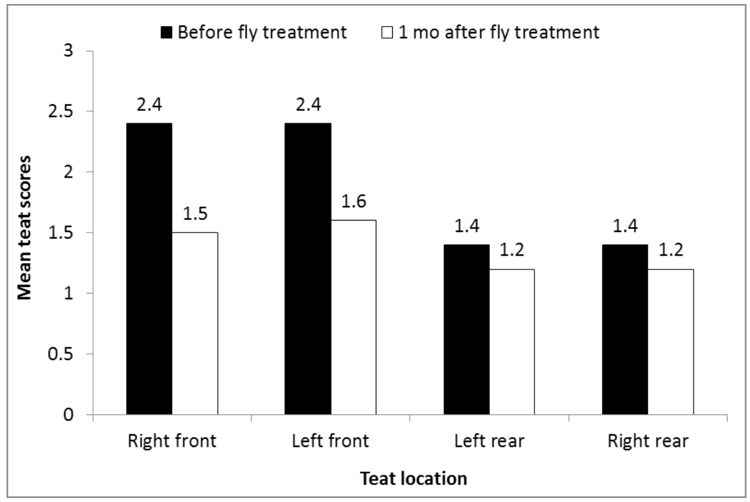



Figure 6. Mean teat skin condition scores prior to, and one month after, pour-on insecticide administration.

Once teat skin condition scores were assigned, pour-on fly treatment was administered. Within two to four weeks of fly treatment, based on qualitative visual assessment, horn fly populations had decreased and teat condition had improved, exhibiting numerically lower scores. For example, one month after administering fly control, average teat scores were numerically lower (right front 1.5, left front 1.6, left rear 1.2, and right rear 1.2) than the scores assigned the previous month (right front 2.4, left front 2.4, left rear 1.4, and right rear 1.4) (Figure 6). This numerical reduction in teat scores illustrates the importance of fly control in replacement heifer management.

An insecticidal pour-on (Eprinex) and ear tag (Patriot) combination was tested over a six-month period in 60 Jersey heifers that were five to 15 months old (Owens *et al.*, 2002). Eprinex pour-on was administered every two weeks for six weeks, followed by the placement of Patriot ear tags (in each ear) of 30 heifers. The remaining 30 heifers served as untreated controls. Following the infection status of both groups of heifers over six months showed that the incidence of new *S. aureus* IMI was three percent among treated heifers and 18 percent among controls, for an 83 percent reduction in the new IMI rate.

Other methods of fly control include the prevention of fly breeding by reducing manure availability by breaking up, spreading, and drying manure, as well as pasture rotation to reduce exposure. Fly traps are also useful: Cows walk through traps on a daily basis and flies get trapped inside, where they are either electrocuted or caught on sticky traps. Topical insecticides other than the impregnated ear tags and the pour-ons already mentioned include residual livestock sprays, dust bags, back rubbers, oilers, and wipe-ons. One such commonly used topical insecticide is permethrin (pyrethrin), which functions on contact by paralyzing the nervous system causing death, or through ingestion by acting as a lethal stomach poison.

Oral larvacides are becoming popular and are used to kill or arrest development of horn fly larvae. Such larvacides are used as feed additives, and are known as insect growth regulators (IGR). Biological control of flies can be accomplished by using predatory mites or dung beetles that feast on developing horn fly larvae. In addition, it's possible to purchase parasitic wasps that lay eggs in horn fly pupae, which hatch into wasp larvae that consume the pupae. Several strains of *Bacillus thurigiensis* (Bt) have been found to be highly toxic to horn fly larvae, but associated products are not yet on the market.

## Current Challenges with Horn Fly Control

A major obstacle to control is insecticide resistance developed by horn flies, but this can be alleviated by several management factors. For example, insecticidal ear tags can be rotated with insecticides having different modes of action; for example, changing from an organophosphate to a pyrethroid. In other cases, withholding ear tagging until horn fly numbers reach 200 per animal may be suitable. Another method is only treating cattle in the growth phase of the animal, during which horn flies have their greatest effect. The use of alternative insecticides and application methods late in the fly season to reduce the percentage of overwintering flies with resistance has also been shown to be effective. In addition, the removal of insecticide ear tags as soon as horn fly numbers begin to decline in the fall has been beneficial. Probably the best way to alleviate resistance is through some form of integrated control; that is, using several methods at once (e.g., fly traps plus biological control, plus ear tags, remembering to rotate chemical use seasonally in the latter).

## Conclusions and Recommendations

Horn flies are a general irritant to livestock, decreasing growth rates as well as milk and meat production. Although not specifically used to control mastitis, a Hoard's (2012) survey reported that 81.1 percent of producers used some type of fly control on farm premises to reduce animal stress. The majority of products were used as a pour-on (44.3 percent) and aerosol (32.4 percent) followed by bait, fly paper, foggers, and others. The good news is that over 80 percent of operations use fly control; it just needs to be incorporated into a heifer mastitis control program. In dairy heifers, flies serve as vectors in the initiation and spread of staphylococcal mastitis, which damages the developing mammary tissues and decreases both milk yield and quality (elevated SCC) during the first lactation.

Such IMI can be treated successfully using nonlactating cow therapy, but prevention is key to controlling this disease. Prevention methods for horn fly control include using pour-ons, ear tags, IGR, biological agents, decreasing manure access, and most importantly, integrated control using a combination of methods. Successful reduction in fly populations will minimize damage to heifers' teat ends, reduce colonization by staphylococci, and help to prevent the development of new IMI. This will allow mammary tissue to develop without the deleterious effects of infection and inflammation, thereby ensuring that heifers freshen with the potential for maximum milk yield and quality for their first lactation.

Although research has not been conducted to show this same association in lactating and dry adult cows, it is possible that elevated fly populations play some role in the elevation of mastitis and SCC observed in the hot summer months. And, with the proposed reduction in the SCC legal limit to 400,000/mL in the United States, and in light of the fact that milk buyers are imposing their own limits, some as low as 200,000/mL, it is imperative that dairymen use all possible means to prevent new cases of mastitis and reduce the associated SCC. A simple fly control program may serve as an important adjunct to an overall herd plan of mastitis control, assisting dairymen in lowering their bulk tank SCC and earning quality premiums for their products.

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