Fly control: reducing disease and productivity losses

The two principal fly pests of confined livestock are House flies (Musca domestica) and Stable flies (Stomoxys calcitrans).

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House flies are a well-known cosmopolitan pest of both farm and home. This species is always found in association with humans or the activities of humans. It is the most common species found on pig and poultry farms, horse stables and cattle ranches.

Not only are house flies a nuisance, but they can also transport disease-causing organisms. Excessive fly populations are not only an irritant to farm workers but, when there are nearby human habitations, a public health problem could occur.

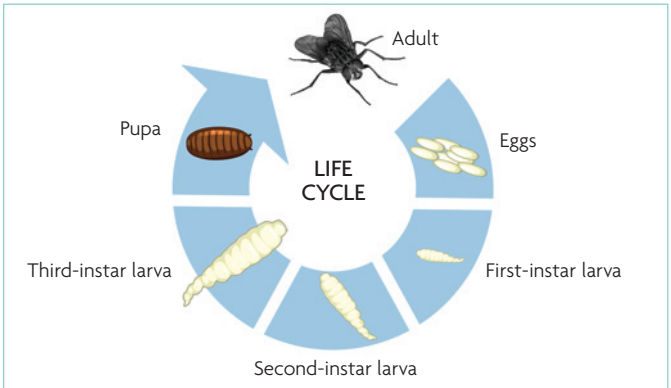
Stable flies are about the size of a house fly, but the adult has piercing mouthparts that protrude spear-like from under its head for blood feeding. Cattle are irritated by these pests, causing a reduction in productivity. The long, bayonet-type mouthparts, called a proboscis, are used to tear through the skin, causing blood to pool at the skin surface. These bites can be quite painful.

The stable fly is one of the most serious pests of confined livestock throughout the United States. In many areas it is becoming a more serious problem for pastured cattle as well, associated with hay waste residues from the large, round hay bales used to feed them. Scientists have calculated that a pair of flies beginning reproduction in April have the potential, under optimal conditions, to be the progenitors of 191,010,000,000,000,000,000 flies by August.

Fly biological and behaviour patterns

House flies lay eggs in organic material including manure and decomposing material which may be located under water leaks and in areas that are difficult to clean.

Fig. 1. House fly and Stable fly life cycle and characteristics.



House fly	Stable fly
Adult flies are 6-7mm in length with reddish eye and spongy mouthparts.	Adult flies are 6-7mm in length, with piercing mouthparts.
Live for 15-25 days	Live for 20- 30 days
Females lay several batches of 75-150 eggs at 3-4 day intervals	Females lay 200-400 eggs
Life cycle egg to adult 7-10 days (optimum summer temperature)	Life cycle egg to adult 21 days

Stable flies at and above 2.5-5.0 flies per leg reduce both weight gain and feed conversion efficiency in feeder cattle.

When house flies land on a surface they vomit, defecate, or both. Vomiting allows the fly to dissolve and consume what may be on the surface. A light brown speck is a vomit spot and a dark speck is a defecate spot.

When house flies are not laying eggs, they are typically found around windows, doors and the ceiling areas of buildings. These resting places are generally near favourite daytime feeding and breeding areas and sheltered from the wind. At night, flies are normally inactive.

Fly eggs hatch, become larvae in the breeding areas before they pupate and finally hatch into adults to repeat the lifecycle throughout the fly season. The house fly development cycle, population density and daily activities, including flight in a particular locality, depend on resource, temperature and other biotic and abiotic factors.

If food is not limiting, flies will complete their life cycle in about 10 days at 29.5°C, 21 days at 21°C and 45 days at 15.5°C. The optimum temperature for fly development is around 26°C with the lower and upper thermal limits of 12 and 45°C, respectively.

Eggs can hatch within nine hours after oviposition and take about 7-10 days to complete egg to adult stage under ideal conditions. However, cooler weather, dry media and scarce food may increase development time to two weeks or more. Flies produce multiple generations per year and the generations overlap; all stages are present at the same time.

Even if the development depends on temperature, multiple generations per year are possible in tropical and temperate regions due to their peridomestic habits.

Different studies have reported different distances that flies can travel, ranging from 3.22km up to 32.19km. The flights are mostly aimed at searching for food and oviposition sites. Flies travel relatively longer in rural areas than urban areas due to widely scattered human settlements. At night, flies are normally inactive.

Stable flies are about the size of a house fly. Both flies are common on dairies, but the physical appearance (especially the mouthparts), behaviour, and posture of the two flies differ. Both flies rest on walls, hay bales, and other vertical surfaces, and may be especially noticeable when they are warming up in the morning in an area lit by the early sunlight.

Stable flies lay eggs in wet straw and manure, spilled feeds, silage, grass clippings, and various other types of decaying vegetation. Cattle are most irritated by stable flies during the summer months. Both male and female stable flies feed on blood several times each day, taking one or two drops at each meal.

Cows' stomping of feet is a good indication that stable flies are present

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Disease transmission and productivity impacts	
House flies	
	Spread bovine mastitis and other diseases
	Transmit antibiotic-resistant bacteria
	Increase bacterial counts in milk
Stable flies	
	Reduced weight gain and milk yield due to fly avoidance behaviours that reduce time spent feeding and resting
	Milk production reduced 1.49kg/day (3.3 lb/day)
	$2.2 billion cost to US livestock industry

Table 1. Impact of flies on disease transmission and dairy productivity.

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because they normally attack legs and bellies. Production performance declines in infested herds because of the painful bites and the animals' fatigue from efforts to dislodge the flies. Stable flies are strong fliers and have been reported to travel long distances from their breeding site around farms or between farms. Stable flies overwinter as larvae or pupae by burrowing in the soil under organic matter.

Disease transmission and impact on productivity

House flies pose a serious health hazard to people and animals by spreading numerous diseases in and around animal rearing facilities and nearby residential areas.

In dairy barns, flies feed on milk leaking from the udders of diseased animals and spread diseases such as bovine mastitis to healthy cows.

Severe housefly infestations may increase bacterial counts in milk. State inspectors routinely note the presence of flies in milk rooms.

Fly control can reduce the spread of disease in farms and, as a result, reduce the need to use antibiotics to treat disease. Flies harbour and spread antibiotic-resistant bacteria on livestock farms.

Controlling these flies can be a means to reduce the spread of antibiotic resistant bacteria. An abundance of flies can also become a serious nuisance both around the farm and in nearby communities.

New neighbours often put great pressure on farmers to keep house fly populations to a minimum.

Stable flies spend much of their life off the animal but will move to animals to bite and feed on blood approximately once per day. When counted this way, an average of more than five stable flies per cow is expected to have economic costs. For young cattle, weight gains can be considerably reduced and feed efficiency is negatively affected resulting in higher feed costs.

The reduction in weight gain and milk yield is primarily due to animals exhibiting fly avoidance behaviours (such as cattle bunching) that reduce their time feeding or resting. Recent research has estimated that stable flies cost the US livestock industry $2.2 billion.

When researchers released large numbers of stable flies in the vicinity of dairy stalls, milk production went down by 1.49kg/day. It is useful also to consider a work in Nebraska, measuring weight gains in beef cattle that were exposed to stable flies in controlled environments.

These studies show that stable flies at and above 2.5-5.0 flies per leg reduce both weight gain and feed conversion efficiency in feeder cattle.

Fly larvae find ideal conditions to develop and grow on dairy sites. Their numbers vastly out number adult fly populations.

Management systems and breeding sites

Each dairy is unique. What is common to all dairies are the fly breeding areas.

Common fly breeding sites include locations in and around:

- Calf hutches, especially in the corners.
- Silo leak and spill areas.
- Animal stalls and pens, feed preparation, storage and manger areas, near water sources.
- Calf, hospital, and maternity areas.
- Water tanks.
- Feed troughs.
- Inside and outside manure handling areas.

Integrated Pest Management

Integrated pest management (IPM) is recommended for implementing a successful fly management program in and around dairies.

- **Monitoring:**

Monitoring of the fly population is an indispensable part of IPM. Several monitoring tools have been developed for adult and larval populations to enable farm managers to monitor for impending emergence of adult flies and provide a basis for timing and frequency of spray applications.

- **Sanitation:**

Sanitation removes fly breeding areas resulting in a reduction in larvae and viable areas for adults to lay eggs. Depending on the type of dairy facility, dry manure management is highly effective in reducing fly populations. Where applicable, frequent removal of manure prevents fly buildup by breaking the breeding life cycle. It is important to scatter the manure lightly outdoors to kill eggs and larvae by drying. Spilled feed should not be allowed to accumulate. Regulate water flow to dairy watering sources and prevent/repair any leaks. Adequate cross ventilation should be provided in the facility.

Ensure proper floor grading so that excess surface water drains away from the facility. Drainage problems that allow manure to mix with mud and accumulate along fence lines in exercise yards should be eliminated. Gaps under feed bunks where moist feed can accumulate should be sealed. Cut grass and vegetation short to remove fly resting areas.

Table 2. Methods of monitoring fly populations

HOUSE FLIES

- **Spot cards** – small 7.5 x 12.5cm index cards fastened in multiple locations within barns where a large number of flies are present. The number of flyspecks (vomit and excreta) on each card gives an indirect estimate of fly populations, and cards should be replaced weekly. Average flyspecks of 50-100 per card indicate a high fly activity and a need for intervention.

- **Sticky ribbons** – tapes with sticky surfaces placed at different locations in barns should be replaced weekly. The tapes can either be stationary or an individual can walk them through the barn for monitoring purposes. The stationary tapes are 3-4cm wide ribbons hung from beams, pillars and other structures, whereas moving sticky paper ribbons are 45cm tapes fully unrolled, suspended about 5-7cm off the floor and carried throughout the barn; the observer should use the same walking pattern at the same time of the day for more accuracy. An average weekly count above 100 flies per stationary tape, or after walking 300m in the barn in case of moving tapes is considered a high fly activity.

- **Scudder grid** – a standard 60cm square grid consisting of 16-24 wooden slats, which is fastened at equal intervals to cover an area of approximately 0.8m^2. After a period of 30-60 seconds, the flies resting on the grid are quickly counted and recorded. The count is repeated 10-15 times in areas with high fly numbers. Sampling should be conducted 2-3 times per week and counts should be carried out at times when flies are active, typically between 10.00 and 16.00 hours. A count of less than 20 flies on a scudder grid is likely to indicate satisfactory fly control.

STABLE FLIES

The best way to measure stable fly activity is to directly observe it during mid-morning on 15 cows standing apart from other cattle in the herd. As stable flies bite predominantly on the lower legs of cattle, approach a single cow from one side and count the number of flies that can be seen on the outside of the front leg facing you and the inside of the opposite front leg. Combine these numbers of flies into a single count to be recorded for each animal. Count only flies oriented with their head pointed upward (toward the cow's head) as this is the feeding posture for stable flies. Other flies that may be on the cow's leg will orient their body differently and should not be counted as stable flies.

LARVAE

In addition to adults, regular monitoring of larval populations is also very important to predict impending fly burst. Routine visual inspection of manure piles for potential hot spots of larval development by walking the length of manure aisles is required. Maggots can also be monitored by pupal traps or extracting immature larvae from manure using Berlese funnels or floating them in 0.6m sucrose solution.

● **Mechanical control**
Mechanical control involves the use of devices to control flies or remove manure. This may include physical exclusion with screens or fans to prevent entry into dairy houses, fly traps, and electric insect killers automatic scrapers for constantly removing manure from buildings.
● **Biological control:**
Biological control should be part of an overall fly control program in dairy operations. The conservation biocontrol includes practices such as provisioning for temporary manure-refuge of natural fly enemies, selective use of less toxic pesticides and manure moisture management at low levels, all aim to increase the efficiency of natural enemies.

The parasitoid wasps, predatory beetles and mites are used for control of juvenile stages of flies. In addition, several species of entomopathogenic nematodes have been extensively studied for their potential as biocontrol agents against flies.

Chemical control

Chemical use around lactating dairy animals is limited. Labels should be read and instructions followed.

Use of insecticides for fly control is an important component in an integrated fly control program directed at reducing fly populations to tolerable levels (see Table 3).

Producers must monitor fly populations on a regular basis to evaluate the fly management program and decide when insecticide applications are required.

Table 3. Chemical fly control application methods.

ADULTICIDES

● **Surface residual spray applications** can also be used for long-term population suppression. They are an effective and economical method to control high infestations of flies and should be applied in the places where the flies rest, including walls, roof, cords, pipes, both inside and outside the buildings. Surface residual spray applications are typically pyrethroids which control the adult flies upon contact with the surface. Pyrethroids will have some repellent activity.

● **Space sprays or mist sprays** are used to quickly knockdown adults. Misting fly resting surfaces with these chemicals is the most common way to suppress overwhelming populations with short residual actions. The low residual activity in turn reduces the possibility of resistance. They should be applied sparingly, maximum twice a week, at regular intervals. Space sprays are applied with ultra low volume sprayers or foggers resulting in small particles hitting the adult flies. Space sprays are natural pyrethrin based with the synergist piperonyl butoxide or organophosphates.

● **Baits** are effective for maintaining low fly populations. They are scattered, in bait stations or, in some cases, as a spray or paint-on application. Most baits contain the sex attractant (Z)-9-tricosene and a neonicotinoid (chemical class). The bait formulations are very useful in trapping and killing adult flies, but the bait stations should be positioned to avoid food and water contamination.

● **Spray baits** are effective as a spot treatment when applied to surfaces. One third of the surface is treated vs 100% with the surface residual treatment. Spray baits typically include an attractant like Z-9-tricosene, and non-repellent insecticide (neonicotinoid). Adult flies are attracted to the treated surface by the attractant and then consume the bait in order to be controlled.

● **Paint baits** are effective when applied to surfaces such as hang boards. They are made by dissolving a water soluble powder in water to form a thick paint solution. Paint bait ingredients are similar to spray baits with adult flies attracted to the treated surfaces to consume the bait and subsequently die.

LARVICIDES

● **Larvicidal feed-throughs** are feed additives that render manure toxic to fly larvae. The great advantage is that this does not require labour.

● **Larvicidal sprays or liquid solutions** are applied directly to the manure surface to kill fly larvae. It is recommended to apply only as a spot treatment with high numbers of larvae to reduce the toxic effect on populations of beneficial insects in the manure.

● **Larvicidal granules** can be applied to difficult-to reach breeding areas. A small fertiliser spreader drops granules into the spaces between the slats allowing a consistent application to breeding areas below the slats.

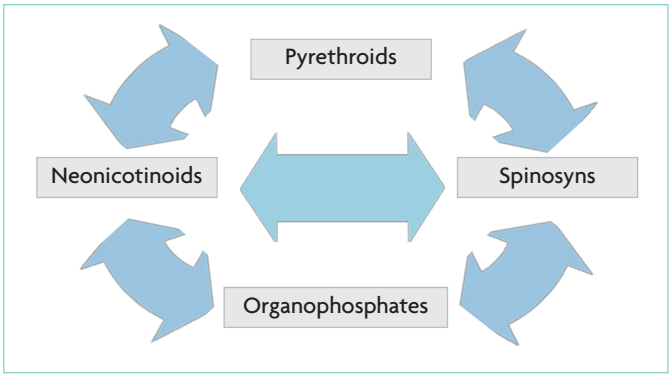

Fig. 2. Rotation plan of insecticides.

Accurate records should be kept on chemicals and dosage rates used. Improper timing and indiscriminate insecticide use combined with poor manure management, poor moisture control, and poor sanitation practices, increase the pest populations and the need for additional insecticide applications.

To manage potential insecticide resistance avoid the unnecessary application of insecticides, use physical or biological control methods, and conserve areas free of chemical treatments where susceptible pests survive.

In situations where pesticides become the only control tool, resistance management requires pesticides to be rotated between different chemical classes deploying different modes of action.

Alternate use of pyrethroids, organophosphates, neonicotinoids, spinosyns, insect growth regulators (IGRs) and other classes of insecticides is recommended

Fig. 2 illustrates an example rotation plan for insecticides, involving some of the main classes of insecticides. It is important to note that rotation between pyrethroids and organo-phosphates is not recommended due to the potential for cross-resistance between these two groups, possibly related to the enzymatic action of esterases or monooxygenases.

IGRs can be used in conjunction with any adulticide application as they are from different chemical classes using different modes of action. Only approved (registered) insecticides should be used according to label directions.

● **Adulticide applications:**
Selective application of chemicals to the walls and ceilings of dairy housing where flies rest as well as the use of baited hang boards and fly baits in bait stations are compatible with biological agents provided these applications avoid contamination of the manure.

● **Larvicidal applications:**
Larvicides are applied directly to the manure to kill maggots. They can be applied as a spot spray, granules or as feed-through premix. Larvicides are primarily IGRs with cyromazine being the leading active ingredient.

● **Stable fly treatments:** Whole-animal sprays can be made directly on the animals. This can provide relief from stable fly bites but the control is short-lived.

Community issues

A confined animal feeding operation (CAFO) is a specific type of large-scale industrial agricultural facility that raises animals, usually at high-density, for the production of meat, eggs, or milk. Residences closest to these operations experience a much higher fly population than average homes. Conflicts between CAFOs and local residents have resulted in public health actions including litigation. As a result, CAFOs must develop and maintain a successful IPM program in order to reduce and control fly populations. ■

References are available from the author on request

KEY POINTS

● House flies and stable flies are a major pest in dairy facilities due to available breeding areas.
● House flies are disease carriers and stable flies are blood feeders that contribute to economic losses.
● Even in small numbers, stable flies reduce productivity and milk production.
● House fly and stable fly populations grow fast and quickly become uncontrollable.
● Flies from CAFOs invading nearby neighbours can result in public health and/or legal interventions.
● A successful IPM program reduces fly populations to tolerable levels.
● Rotating classes of insecticides used is key to avoiding resistance
● Sanitation, the removal or treatment of breeding sites is key to successful fly control.