Fly control: reducing disease and productivity losses

The house fly (Musca domestica) is an established pest of both farm and home. Excessive numbers of flies in poultry facilities are unacceptable for several reasons: not only are house flies a nuisance to workers, but they also act as vectors for disease transmission. When fly populations are not properly managed, they can become a public health nuisance around poultry operations and neighbouring rural non-farm communities. This often leads to poor community relations and potential litigation.

by Richard J. Hack, RJH Consulting LLC, USA.

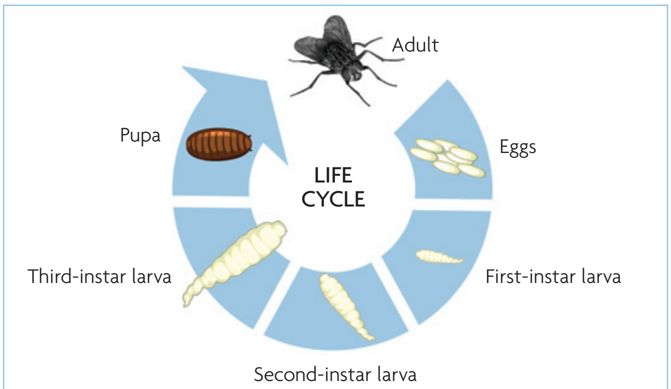
	Disease transmission and productivity impacts
House fly	
	• Transmit viruses responsible for Newcastle disease and avian influenza virus
	• Transmit bacteria: Shigella spp., Vibrio cholerae, E. coli, Staphylococcus aureus, Salmonella spp. Klebsiella spp., Enterobacter spp., Aeromonas spp, Campylobacter spp.
	• Vectors for protozoan parasites and eggs of several tapeworms
	• Transmit antibiotic-resistant bacteria
	• Cost › $1bn to the US poultry industry every year

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

Flies also negatively impact production performance as a result of the stress they put animals under. In cases of heavy infestations birds can be overwhelmed and drastically reduce their consumption of food, with a resultant decrease in the production of meat and eggs.

Flies defecate and regurgitate which causes spotting on structures and equipment, on light fixtures (reducing illumination levels), and on eggs (presenting potential for transmission of pathogens on freshly laid eggs). This reduces the eggs' attractiveness to customers and compromises market value.

Fig. 1. House fly life cycle and characteristics.



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

Although it is difficult to estimate the direct production losses related to fly-borne disease, in the US poultry industry alone, flies are responsible for damage and control costs exceeding a billion dollars a year. In 1979 the direct cost of fly control was estimated at $0.13 per bird per year.

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 million flies by August.

Fly biological and behavioural patterns

Fly eggs hatch in breeding areas to become larvae before they pupate and finally hatch in adults. This lifecycle is repeated 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 the 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.

Both male and female flies feed on all kinds of human and animal food, garbage and excrement. Liquid food is sucked up and solid food is wetted with saliva, to be dissolved before ingestion.

Disease transmission and impact on productivity

The house fly is an important mechanical vector of many human and poultry diseases (protozoa, bacteria, viruses, rickettsia, fungi and worms) and can cause fly specking problems on eggs as well as the windows and walls of buildings.

Pathogenic organisms are picked up by flies from garbage, sewage and other sources of filth, and then transferred on their mouthparts, through their vomit, faeces and contaminated external body parts to human and animal food.

Some pathogenic micro-organisms ingested by the larvae close to becoming pupae can remain viable during the entire pupal stage until the emergence of the adult fly.

Fly control could be considered as a way to reduce the spread of disease in farms and, as a result, reduce the need to use antibiotics to treat those diseases. Flies harbour and spread

Continued on page 29

Continued from page 27
antibiotic-resistant bacteria both on livestock farms and in hospital environments. Controlling these flies can be a means to reduce the spread of antibiotic resistant bacteria.

The species Musca domestica has been implicated as a mechanical vector of pathogens such as the paramyxovirus that causes Newcastle disease, and of transporting the avian influenza virus for a period of 72 hours post-infection.

They also act as vectors for bacteria such as Shigella spp., Vibrio cholerae, Escherichia coli, Staphylococcus aureus, Salmonella spp. Klebsiella spp., Enterobacter spp., Aeromonas spp., Campylobacter spp., as well as protozoan parasites and eggs of several tapeworms. Flies are known to carry organisms associated with food poisoning in humans, such as Salmonella spp., Campylobacter spp., E. coli and Listeria spp.

Nuisance caused to workers by houseflies can also cause a loss of productivity as workers waste time swatting flies from their face and may even avoid working where the fly populations are intolerably high.

Management systems where flies are an issue

Flies are an issue in poultry facilities where manure breeding sites are abundant and manure management is poor. Usually, manure collects under the birds until the flock is harvested which varies from five weeks in broiler production to more than 52 weeks in egg layer production.
The ease with which flies can move between the inside and outside of the poultry houses as well access to fresh manure helps to facilitate their development and persistence on farm.

Types of poultry facilities include:

- Houses with birds maintained on the floor (without cages), with free access to feed and water (turkeys, ducks, broiler chickens).
- Houses with no, or partial, litter system with a raised slatted area where the watering equipment, hen feeding equipment and nest boxes are located (broiler breeders or free-range layers). Manure falls under the slatted area which is usually not accessible.
- Houses with caged layers, where the manure falls into a pit under the cages (layer hens).

In caged layers or aviaries where belted systems are installed, manure is collected on belts and removed frequently to a manure-drying facility. This practice results in very few fly breeding areas and low house fly populations.

Fly larvae find ideal conditions to develop and grow. They vastly out number adult fly populations.

Integrated Pest Management

Integrated Pest Management (IPM) of fly populations is the recommended protocol for implementing a successful fly management program.

Monitoring

Monitoring of the fly population is an indispensable part of poultry 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 (see Table 2).

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 poultry facility, dry manure management is highly effective in reducing fly populations.

This is accomplished by proper building design and ventilation to maximise air flow over the manure, by provision for drainage of water away from the house, and by careful maintenance of the bird watering system to minimise leaks.

To conserve part of the heterogeneous manure fauna, especially fly predators and parasites, the manure should not be totally removed in one brief span of time.

Whenever possible, portions of the manure should be removed in a staggered schedule, preferably during the cooler months when there is low fly activity; a base of old manure should be left to provide absorbency for the fresh manure as well as harbourage for beneficial arthropods.

Mechanical control

Mechanical control involves the use of devices to control flies. This may include physical exclusion with screens or fans to prevent entry into poultry houses, fly traps, and electric insect killers. Electrocuting traps are not practical for the control of high fly numbers based on the number of units required and the costs involved.

However, these units may be suitable for smaller product handling, offices, and related areas near to the poultry houses.

Biological control

Biological control should be part of an overall fly control program in poultry 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.

Release of the correct species and strains at the right time and number are necessary for successful control.

In addition, several species of entomopathogenic nematodes have been extensively studied for their potential as biocontrol agents against flies. Insect disease-causing micro-organism are promising biocontrol agents in controlling flies and several studies have attempted to screen virulent isolates and to develop appropriate formulations and field application strategies.

Similarly, plant materials and plant-derived essential oils have been used since ancient times to repel or kill flies and have drawn a renewed interest for commercialisation and use in poultry IPM.

Continued on page 31

Flies can contaminate feed and spread poultry diseases.

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 poultry facilities 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.

- **Baited jug traps** – a small one-gallon, plastic milk-jug with four holes on each upper side and insecticide infused pheromone bait inside is hung in several locations inside barns and periodically assessed for the numbers of captured flies. An average count of 250 flies per jug trap per week indicates that control measures should be initiated.

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.

Continued from page 29

Chemical control

Use of insecticides for fly control is an important component in an integrated fly control program. It is impossible to eradicate all flies, so control practices are directed at reducing fly populations to tolerable levels (see Table 3). Producers must monitor fly populations on a regular basis in order to evaluate the fly management program and decide when insecticide applications are required. 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 those situations, where the use of pesticides becomes the only control tool, resistance management requires a rotation of the pesticides, which must 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.

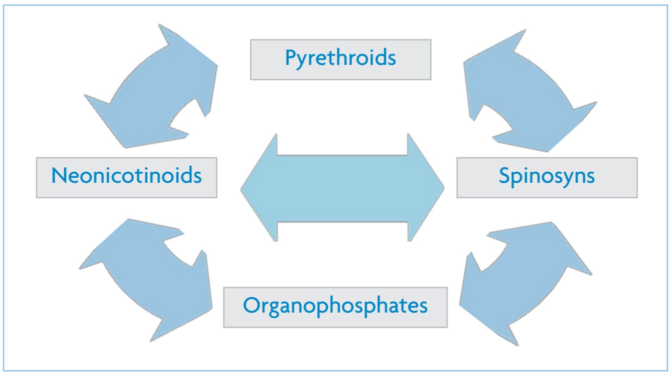


Fig. 2. Rotation plan of insecticides.

Fig. 2 illustrates an example rotation plan for insecticides, involving some of the main classes of insecticides on the market. It is important to note that rotation between pyrethroids and organophosphates 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 poultry 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. The use of fly baits and selective application of fly control chemicals to the interior upper portions of the poultry house where flies rest are compatible with biological control agents.
- **Larvicidal applications:** Larvicides are chemicals applied directly to the manure to kill maggots. They can be applied as a spot spray, as granules or as feed-through premix. Larvicides are primarily IGRs with cyromazine being the leading active ingredient. Using cyromazine as a feed additive or in direct application to the manure is acceptable because that chemical is relatively non-toxic to predacious mites and beetles.

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 have arisen between communities and operators of CAFOs as farms have become bigger in order to maintain their competitiveness. Conflicts between CAFOs and local residents when flies invade their neighbourhoods have resulted in public health actions including litigation. Due to the above, the CAFOs must develop and maintain a successful IPM program, thus reducing fly populations. ■

References are available from the author on request

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. Spinosad is another example that fits in this category.
- **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 at bird level in high-rise layer barns, but the bait stations should be far enough from birds' cages 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 such as thiamethoxam). 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**, such as cyromazine, are feed additives that render bird manure toxic to fly larvae. The great advantage is that this does not require labour.
- **Larvicidal sprays or liquid solutions**, such as cyromazine and spinosad, 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.

KEY POINTS

- House flies are a major pest in poultry facilities due to the amount of available breeding areas.
- House flies carry diseases such as Newcastle disease, avian influenza, and E. coli related diseases.
- House fly populations can grow fast and become uncontrollable in a short period of time.
- Fly populations from CAFOs invading nearby neighbours can result in public health and/or legal interventions.
- A successful IPM program will result in managing fly populations to tolerable levels.
- Rotation among the right chemical classes of insecticides is key to avoid resistance development.
- Sanitation, the removal or treatment of breeding sites, is key to a successful fly management program.
- Fly control could be considered as a way to reduce the spread of disease in farms and, as a result, reduce the need to use antibiotics to treat those diseases. Controlling these flies can be a means of reducing the spread of antibiotic resistant bacteria.