Fly control: reducing disease and productivity losses

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

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Because of the availability of vast quantities of manure, pig units provide a perfect environment for the breeding, feeding and settling of various types of flies: for example, stable flies (Stomoxys calcitrans), the common housefly (Musca domestica) and the lesser housefly (Fannia canicularis). Of these species, the housefly is most frequently encountered around pig houses.

Scientists have calculated that a pair of flies beginning reproduction in April have the potential, under optimal conditions, to be 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. 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. Light brown specks relate to vomit and dark spots relate to defecation. 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. The distribution of fly populations is greatly influenced by their reaction to light, temperature, humidity as well as surface colour and texture.

At very low temperatures, the species can stay alive in a dormant state in the adult or pupal stages. Different studies have reported different distances that flies can travel, ranging from 3.22km up to 32.19km. These flights are mostly in order to search for food and oviposition sites. Flies travel relatively longer distances in rural areas than urban areas due to the wider dispersal of human settlements.

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.

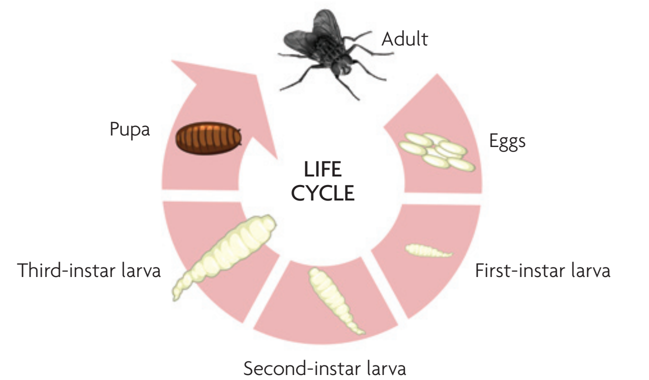
However, cooler weather, dry media and scarce food may increase development time up to two weeks or more. Flies produce multiple generations per year and the generations overlap; all stages are present at the same time.

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

Disease transmission and productivity impacts	
House flies	
	Transmit many pathogens such as salmonella, anthrax (Bacillus anthracis), E. coli, hog cholera virus and Haemolytic streptococci, PRRS virus.
	Vectors for nematode eggs.
	Transmit antibiotic-resistant bacteria.
	Can result in a 10% loss in average daily weight gain.
Stable flies	
	Transmit African swine fever (ASF)virus

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

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)

Disease transmission and impact on productivity

House flies are non-biting, but by crawling over an animal's skin they are bothersome and can transmit many pathogenic organisms, such as salmonella, anthrax (Bacillus anthracis), Escherichia coli, hog cholera virus, Haemolytic streptococci, and nematode eggs. Dissemination of these and other pathogens occurs via the fly's exoskeleton (hairs, legs, proboscis), regurgitated from the fly's crop while dabbing its proboscis on food, or in the fly's faeces.

In addition, houseflies can mechanically transmit PRRSV (porcine reproductive and respiratory syndrome virus) and may contribute to its horizontal transmission among pigs within infected commercial farms. Stable flies are biting flies that feed on blood, and are capable of mechanically transporting African

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swine fever virus. Flies make contact with faeces, skin, and discharges of the pig. If the number of flies in the environment reaches a high enough level they can become major transmitters of disease organisms, not only within a building, but also between buildings and sometimes between pig herds.

Major outbreaks of greasy pig disease and coccidiosis can be maintained by very high fly populations. When sows are sick with mastitis, flies are attracted to the udder and skin surfaces in great numbers and they can be responsible for enhancing severe outbreaks.

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 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.

Fly control in all piggeries must be continuous in summer months. The aim is to prevent flies from breeding and to destroy adult flies. Breeding of flies can be prevented by regular removal of dung. Insecticides are effective in the form of sprays and baits.

A field study was conducted to compare the production difference between one room of growing pigs that provided fly control when the room was treated (treated) for fly control with an adulticide (Agita 10 WG, Elanco) and larvicide (Neporex 50 SP, Elanco) to a room of pigs that received no fly control treatments (untreated).

In the treated room a mean of 1.3 flies per glue trap were counted each day; and in the untreated room, a mean of 13.8 flies per glue trap were counted every day. In the untreated room the pigs reached the slaughtering weight within 121 days and 49 dead pigs were recorded (3.3% mortality). In the treated room, the pigs required 109 days to achieve the same target weight, i.e. 12 days less than in untreated room with 33 dead pigs (2.2% mortality). The average daily weight gain (ADWG) was 718g/day in the untreated room and 809g/day in the treated room. Statistically significant difference (p=<0.0001) in fly counts was recorded between the rooms.

Due to the longer fattening period of pigs housed in the untreated room, the extra feeding costs were €14,947 for the 1,418 pigs finally sent to the slaughterhouse. Pigs performed differently with statistically significant improvement of 10% in ADWG in pigs housed in the treated room.

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

Description of management systems and breeding sites

During the fattening phase, pigs are normally housed in large rooms where large fly populations are common. In semi-protected indoor settings of animal production units, the generation of manure and waste nourishes and multiplies flies by providing favourable dwelling and breeding sites, and the fly population frequently reaches pest and vector status imposing a significant economic cost in affected rearing facilities.

Integrated Pest Management

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

Monitoring

Monitoring of the fly population is an indispensable part of pig 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

The most important aspect of pest control is year-round farm hygiene, which will prevent fly infestations from happening. Sanitation removes fly breeding areas resulting in a reduction in larvae and viable areas for adults to lay eggs. Rubbish should be removed regularly and stored in closed containers. Depending on the type of pig facility, dry manure management is highly effective in reducing fly populations. Manure should be removed daily from pig pens and areas around feeding stations, and feed storage should be cleaned frequently. Manure piles should be covered: the rise in temperature will render them as breeding sites. Farmers should aim to keep solid manure as dry as possible to prevent hatching. Maintain grass and cut vegetation short to remove fly resting areas.

Flies can contaminate feed and spread swine diseases.

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 pig houses, fly traps, and electric insect killers and automatic scrapers for constantly removing manure from buildings.

Biological control

Biological control should be part of an overall fly control program in pig operations. Conservation biocontrol 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. 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-organisms are promising biocontrol agents in controlling flies and several studies have attempted to screen virulent isolates and to develop

Table 2. Methods of monitoring fly populations

HOUSE FLIES

● **Spot cards** – small 7.5 x 12.5cm index cards fastened in multiple locations within sheds 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 pig facilities should be replaced weekly. The tapes can either be stationary or an individual can walk them through the shed 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 shed; 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 shed 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.

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.

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 recently drawn a renewed interest for commercialisation and use in pig IPM.

Chemical control

Chemical use around lactating pigs 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. 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.

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 pig level, but the bait stations should be far enough from food and water to avoid 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** are feed additives that render animal 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. In the presence of high larva populations, it is recommended to apply a larvicide as a spot treatment to reduce any effect on populations of beneficial insects in the manure.
- **Larvicidal granules**, such as cyromazine, 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.

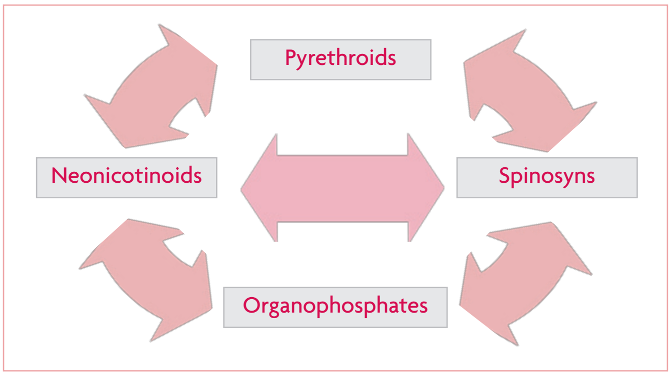

Fig. 2. Rotation plan of insecticides.

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 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 pig facilities 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 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.

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 these 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.

As a result, the 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 are a major pest in pig facilities due to the amount of available breeding areas.
- House flies are carriers of diseases such as salmonella, anthrax, E. coli, hog cholera virus, Haemolytic streptococci and swine mastitis.
- House fly populations can grow fast and become uncontrollable in a short period of time.
- House fly infestations can reduce ADWG by up to 10%.
- 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.