

CROP PROFILE FOR SWINE IN VIRGINIA

Prepared: March 2008



GENERAL PRODUCTION INFORMATION

- Virginia was ranked 18th out of 50 swine-producing states in 2006, down from 17th in 2005.
- Most swine in Virginia are raised in the south-central and southeast counties, including Suffolk, Southampton, Surrey, Isle of Wight, Virginia Beach, Buckingham, and Halifax counties.
- Over half of the swine in Virginia are produced for Murphy-Brown LLC, the world's largest hog producer and a division of Smithfield Foods.
- There were 365,000 hogs and pigs on 850 farms in Virginia as of December 2006, of which 30,000 were breeding swine, while the remaining 335,000 were destined for the market. Swine totals were 125,000

fewer than the previous year.

- The 2006 pig crop totaled 548,000 animals.
- Cash receipts totaled \$69,680,000 for 2006. The average price per 100 lbs. on a live-weight basis was \$42.60.

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CULTURAL PRACTICES

The major breeds of swine grown in Virginia are Hampshire, Landrace, Duroc, and Yorkshire (Large White). Other breeds include Berkshire, Spotted, Chester White, Poland China, and Pietrain. However, the majority of pigs reared on commercial hog farms in Virginia and most other states are crossbreeds or composites of the aforementioned breeds. The white breeds (Yorkshire, Landrace, and Chester White) tend to have excellent reproductive traits, including larger litter size, greater milk production, and submissive temperament. White breeds also tend to flourish indoors rather than in pastures. The colored breeds are less susceptible to sunburn, better able to withstand stressful situations, and tend to be more lean and muscled than the whites. Today's pigs are bred to be more heavily muscled and to have less back fat than in previous generations.

Pigs are raised using systems approaches, either in pastures or enclosed barns. Pasture or outdoor production uses more land and more labor. The starter costs are lower, but this rearing method is less productive in terms of output. However, if managed effectively, pasture production can compete with controlled operations. Controlled environment facilities cost more to establish and maintain but require less labor per market hog. This system is operated in an "all-in, all-out" fashion (a group of pigs arrive and leave together

without overlapping other groups), and the facilities are thoroughly cleaned and disinfected between groups. Both swine and workers are protected from the elements. The employees can monitor the animals more easily, which allows for greater control over production practices, increased feeding efficiency, and faster growth-to-market weight. Furthermore, this production practice uses less land, so more farm space can be dedicated to feed and grain production.

Production facilities fall into three main categories: barn, hoop, and pasture. Barns have controlled environmental conditions and typically hold 20 to 50 growing pigs per pen. These facilities are naturally or mechanically ventilated; maintain manure and pigs separately; are easy to clean; may or may not provide animal bedding, and have multiple pens allowing for separation by sex, age, or size. In addition, pest control is easier, and less time is spent watching and managing the swine. However, barns are costly, power outages can be deadly to the animals, swine must be adequately fed since they cannot forage, and diseases are spread more easily due to close contact with other hogs.

The hoop system is far cheaper and can house groups of 100 or more pigs, which have 50% more space than those reared in barns. Hoop houses are used for gestation and grow-finish stages, but not for giving birth. Environmental conditions can be maintained moderately well, and the facilities can be used for other purposes once the swine have been sent to market. However, lots of bedding material is required to absorb all the fecal matter, hoop houses are harder to keep cool in the summer, they are not as easy to keep clean, sick animals are harder to identify, and more labor is required to care for the pigs.

Pigs that are reared on pasture remain there for their entire lives until they are sent to market. This method is cheap, but it requires a lot of land because swine must be rotated between pastures to prevent the spread of certain diseases found in infected soil. Some pig farmers have intensive production systems but rotate their animals to pasture at some point. Pasture pigs are able to live free and get adequate exercise. They are also less likely to contract diseases that are more commonly seen with indoor management techniques. Furthermore, pasture-raised pigs can be cheaper to feed because they may be able to forage and obtain some nutrition from the land, although supplementary feed is critical for good performance. However, pasture production is far from perfect. It can be difficult to control environmental conditions, and predators are a concern, as are diseases and parasites contracted from wild animals and the land. Finally, more labor is required to treat and manage each pig.

There are five specific types of buildings used for the grow-finish phase: 1) *Totally enclosed, controlled environment* – the most expensive but provides the greatest control over swine living conditions, electric fans provide ventilation; 2) *Open front with outside apron* – less expensive because south-facing side always left open, less comfort and performance because of temperature fluctuations; 3) *Modified open front* – south-facing side opened in summer to improve air flow and closed in winter, natural ventilation provided by convection currents; 4) *Double curtain buildings* – major new development in hog-rearing technology, automatic curtains on sides situated perpendicular to winds, mechanical and natural ventilation, sometimes tunnel ventilated with big fans at one end,

must hold 800 pigs “all in, all out” to make it economically lucrative; and 5) *Hoop buildings* – wooden or concrete walls 3 to 4 ft. high with mounted hoops overhead that hold covers made of fabric or straw, straw or cornstalks used for bedding on dirt floor, cost competitive with as few as 200 hogs in an “all-in, all-out” fashion.

Different mating procedures are used depending on what production system is in place. In pasture production, usually one or two boars are placed with several sows in a pen, although it is difficult to know precisely when or if mating has occurred. Another method used in controlled operations is hand mating, which involves placing one boar and one sow together while watching to see if mating occurs. A third option is artificial insemination, which is most common because it allows for quick introduction of sperm and limits disease transmission. Artificial insemination is very common on intensively managed farms. Most pigs in the United States (> 80%) are produced from this mating technique. This method requires the most labor and training of these three breeding methods.

Pigs have a 114-day gestation period. Sows (mature female pigs) are either kept in groups in pastures or in buildings, or alone indoors. As in all livestock production, it is very important to keep stress levels low to maintain large litter sizes and piglet vigor. Farrowing occurs when sows give birth in either individual huts (pasture production) or enclosed farrowing houses with individual stalls (controlled environment production). Sows are segregated in order to provide them with a safe, private location to give birth. This also means piglets are less likely to be crushed and workers are less likely to be injured by protective mothers. Huts and stalls are thoroughly decontaminated before entry and are used in rotation to minimize disease transmission. Each sow usually gives birth to nine or ten piglets per litter, although the range is six to 13. Baby pigs must be well cared for in the first few days of life to keep mortality low, thus maximizing profits. Newborns undergo several procedures to improve their odds of survival: disinfecting their navels, clipping their needle teeth to prevent injury to other pigs, administering extra iron, docking their tails, and castrating boars. The latter procedure prevents off-flavored meat when the pigs reach market weight.

Piglets are weaned at two to four weeks of age once they reach 10 to 15 lbs. Hogs then head to a nursery, grower building, or finishing facility for young pigs. Wean-finish buildings typically feature completely slatted floors to allow waste to pass through. The diet consists of grain, plant proteins, milk products, and animal proteins. Swine leave nurseries at eight to ten weeks (40 to 60 lbs.). If they are already in a wean-finish building, they are switched to a growing diet to add weight. In previous years, pigs were brought up to 120 lbs. in growing buildings, then brought up to market weight (240 to 280 lbs.) at finishing facilities. Swine are no longer moved at the 120 lbs. mark. Instead, they are given variable diets that address their nutrition needs at each stage of their development. Barrows (castrated males) and gilts (unmated females) may be fed separately because of distinct differences in feeding requirements. This “split-sex” feeding method yields leaner, meatier pigs with less feed. Properly tended hogs gain more weight faster and are less likely to need excessive veterinary care. Mortality is also greatly reduced.

Hogs are sent to market once they reach approximately 265 lbs. They are sold on a live-weight basis at terminal markets and auctions, or based on live or carcass weight to meat packers. Most market hogs are sold directly to packers; less than 1% of hogs are sold through terminal markets. Hogs are usually sold on a “carcass merit” system, where their characteristics dictate part of their price. The most desirable hogs are heavily muscled with very little fat. Pork products, in addition to meat for consumption, include heart valves, skin grafts, insulin, gelatin, glue, cosmetics, and plastics. Furthermore, manure can be used as fertilizer, most often on the same farm where it was produced.

Several environmental issues have surfaced with the encroachment of neighborhoods on large-scale hog farms. Odor control, manure management, and on-farm mortality disposal are all of great concern to producers and those who live nearby. Researchers continue to study methods to lessen the impact of hog waste in water and the air. Hoop-type and open-front buildings hold manure in solid form while other types of buildings have liquid storage tanks. Offensive swine odors can be minimized by properly maintaining animal housing, manure storage areas, and crop fields to which manure is applied. It is important to keep indoor walls clean and dry and to make use of exhaust hoods, if available. Trees can be planted around the facilities to reduce swine odor. Lagoon liquid can be injected or mixed into the soil after application, but it should never be sprayed when conditions are windy to avoid odor drift. Swine feed can also be modified to limit unpleasant odors. Pig effluent, known to be high in phosphorus, can cause waterways to become eutrophic and inhospitable to native wildlife if allowed to reach ground- or surface water. However, under proper conditions, swine waste can be safely applied to land. Moreover, research has shown that by providing hogs a low-phosphorous/high phytase diet, phosphorus excretion was reduced by 21%. Swine in Virginia are being fed in this manner with favorable results. In the past, dead pigs were disposed of by on-farm burial or cremation. However, those methods pose certain environmental risks. A third method is to turn the carcasses over to rendering plants, although this is difficult if the facilities are located far away. Consequently, many Virginia farmers are turning to composting, which was first used in poultry disposal. Composting, when done properly, produces very little odor, reduces insect and scavenger problems, is biosecure, and poses a low risk of pollution. In addition, the resulting compost is an excellent material for improving soil fertility.

WORKER ACTIVITIES

Livestock may be treated for parasites at any time of the year. Potential hazards include exposure to pesticides and injury resulting from animal handling. Livestock are large and unpredictable, and can cause injury if they are not handled properly while pesticides are applied. Risks of pesticide exposure are greatly reduced by following the recommendations on the product label and wearing personal protective equipment such as eyewear, face shields, boots, coveralls, gloves, masks, and hats. Workers are most likely to be exposed to pesticides while handling or mixing products before they are applied. Exposure via the skin, mouth, or nose is possible if pesticides are spilled, splashed, or become airborne during preparation. Dermal, oral, and inhalation exposure are also possible during the treatment itself. Workers may be exposed to pesticides when

using high-pressure sprayers (75 to 100 psi) or power dusters to control pests. Pour-on treatments can permeate farm workers' skin or clothing if an animal moves unexpectedly during the application process. Injectable products also present a risk of injury, particularly if animals are not properly restrained. Nonpermeable gloves should be worn when placing rodent-control products on the premises. Additionally, pesticide-impregnated plastic strips hung in livestock houses pose a risk of dermal or oral exposure to those who hang them.

SPECIAL USE LABELS

Section 18 Emergency Use Exemption and Special Local Need (SLN) 24 C labels are used to supplement the chemical tools available to producers for pest control. Once the problem or gap in pest control has been identified, specialists submit the proper documentation for the Emergency Use/Special Local Need label. Emergency use exemptions are usually associated with an emergency or crisis situation (need). Special local need labels are associated with a regional or local need not fulfilled by a Section 3 (nationally registered) product. Section 3 labels are often regarded as permanent labels while Section 18 and Section 24C labels are often regarded as temporary. Thus far, Extension specialists have been successful in obtaining these labels. Special Local Need labels in Virginia are granted by the Virginia Department of Agriculture and Consumer Services (VDACS) and are usually only valid for limited time intervals. Section 18 Emergency Use labels are evaluated and granted by the Environmental Protection Agency (EPA) and can be renewed annually. All registrants are required to pay an annual registration fee to sell their pesticide products sold in Virginia.

ARTHROPOD PESTS

External parasites cost \$30 to \$200 million in annual losses. The two major external pests of swine are lice and mange mites, which are known vectors of diseases such as swinepox. Pesticides are not used extensively on swine farms. For the most part, cultural controls such as implementing good sanitation and drainage are the main control methods to limit flies and other pests attracted to swine effluent.

Insects

Semi-Aquatic Biting Flies

Mosquitoes, *Aedes*, *Culex*, and *Ochlerotatus* spp.

Deer and Horse Flies, *Chrysops* and *Tabanus* spp.

Biting Midges (Gnats), *Culicoides* spp.

Mosquitoes are small flies that breed in stagnant water. Female mosquitoes are blood feeders whereas the males feed on nectar. Mosquitoes are more active at dawn, dusk, and during the night. Mosquitoes, deer flies, and horse flies are potential vectors of swine diseases. Deer and horse flies are medium to large blood-feeding flies that lay eggs on or near aquatic plants. The bite wounds continue to bleed after the flies have gone, which

attracts other flies. Adult deer and horse flies are most active on warm, sunny days. The biting midge, *Culicoides sonorensis*, is a very small blood feeder that is active at dawn and dusk. Midges occur mostly in wet, marshy areas. Females lay their eggs in moist habitats. Biting flies are economically damaging to hog producers if red welts develop and the hide must be trimmed, thus decreasing the carcass weight.

- **Monitoring:** Watch for insect activity around animals that causes annoyance and interrupts grazing, leading to reduced weight gain. Animals will seek shelter from attack in dark, secluded locations.
- **Chemical Control:** Repellent sprays may provide temporary relief from deer and horse flies. Insecticides can be used on livestock facility walls. See the *Chemical Arthropod Control* section for more information.
- **Biological Control:** No commercially effective controls are available.
- **Cultural/Mechanical Control:** Improve sanitation, provide darkened shelters or shady areas for escape from deer and horse flies, keep animals away from wooded or marshy areas, drain wet areas, and empty containers that collect water. Trim grass and weeds around facilities. Install insect screen on swine production facilities, if it is cost-effective. Seek veterinary advice to verify that bites are from flies and not from some other pest.

House Fly, *Musca domestica*

House flies are nonbiting pests, but they annoy livestock and people. They can also carry diseases and are a threat to public health. Eggs are laid in straw, spoiled grain, or other rotting organic matter. Several overlapping generations are produced each year, taking as little as one week to develop. Flies are active from May to October but are most prevalent in August and September. Some flies overwinter in buildings as larvae or pupae.

- **Monitoring:** House flies gather inside and on buildings and leave vomit and fecal spots on walls. They can be monitored by using baited traps, sticky tape, or spot cards. If more than 100 “fly specks”/card/week are found, then begin low-residual pyrethrin control.
- **Chemical Control:** Residual wall sprays should be used sparingly because flies are becoming resistant. Alternate insecticides to limit resistance. Short-term control can be used to treat the legs and underside of animals. Space sprays (pyrethrins), mist foggers, and baits (methomyl) work well with biological control methods. See the *Chemical Arthropod Control* section for more information.
- **Biological Control:** Beneficial wasps (e.g., *Muscidafurax raptor*) that attack pupae are available for purchase and release. Other natural enemies, such as beetles and mites, are present in barns and should be protected. Residual space

sprays (e.g., permethrin and Rabon) are very toxic to natural enemies. Use these only as a last resort.

- **Cultural/Mechanical Control:** Remove breeding sites twice each week (feed bunk areas, spilled/wet feed in troughs, and manure-covered bedding, especially in damp, low-lying areas). Plug gaps under feed bunks. Thoroughly clean stalls and stanchion barn gutters. Either spread manure thinly to dry and disk it under, or add it to a liquid manure pit. Use flypaper (change every one to two weeks), electrocuting traps, bait traps, and automatic misters. You can make traps using white freezer paper covered with sticky adhesive and baited with a mixture of molasses, water, grain, and milk. Place bait traps every 20 to 30 ft. around the fly-breeding area perimeter. Reduce traffic going in and out of buildings, and control any remaining flies with sticky tapes and traps.

Lice, *Haematopinus suis*

Hog lice are quarter-inch-long blood-sucking ectoparasites found primarily on the neck hair, behind the ears, and in the skin folds of swine. The life cycle from egg to nymph to reproductive adult takes approximately one month. Adult lice typically live for just 35 days. Once sexually mature, female lice lay 75 to 100 eggs at a rate of three to four eggs over a 25-day period. Eggs are affixed to swine hair shafts and hatch after one to three weeks. When feeding, lice tend to congregate on sensitive areas of the skin around the ear, then move to the lower body, and finally end up on the abdominal areas. Lice may vector swinepox and other diseases, and can live for two to three days off the swine host in warm bedding material. However, lice are spread primarily from pig-to-pig contact. These pests are more common in outdoor and bedded systems than in confinement barns.

- **Monitoring:** Heavy infestations of lice appear as bluish black skin discolorations. The skin of afflicted animals may also become irritated and itchy. Hogs may become restless, exhibit loss of appetite, or lose weight. Piglets may become anemic.
- **Chemical Control:** The Virginia Pest Management Guide recommends using sprays (coumaphos 25%, tetrachlorvinphos 50%, amitraz 12.5%, fenvalerate 10%, phosmet 11.6%, permethrin 11%); dusts (coumaphos 1%, tetrachlor 3%, permethrin 0.25%, malathion dust 4%); pour-ons (amitraz 2%); and injectables (ivermectin 1%; Ivomec for sucking lice). See the *Chemical Arthropod Control* section below for more information.
- **Biological Control:** None are currently recommended.
- **Cultural Control:** Good biosecurity measures should be implemented to prevent the introduction of lice by way of infested pigs, feeder pigs, or breeding animals. New animals should be isolated until they can be treated for diseases and pests.

Stable Fly, *Stomoxys calcitrans*

Stable flies resemble house flies, but both males and females take blood meals. Although uncommon in swine facilities, they can annoy animals with their painful bites and will pursue their hosts over long distances to feed on their legs and bellies. This leads to fatigue, reduced grazing, and weight loss. A new generation will arise about every three to four weeks between May and October from eggs laid in manure, rotting straw, grass clippings, or piles of harvest residue. Adult flies will enter buildings in bad weather, but they prefer to rest outside in sunlight. Immature flies will overwinter as larvae or pupae in breeding material. Stable flies can transmit brucellosis, hog cholera, and leptospirosis.

- **Monitoring:** Stable flies are most prevalent and annoying in the spring and summer. Cattle exhibit leg stamping, tail switching, and bunching when under attack. If the number of flies exceeds an average of ten per animal, then begin treatment.
- **Chemical Control:** See the *Chemical Arthropod Control* section for more information.
- **Biological Control:** Beneficial wasps (e.g., *Muscidafurax raptor*) that attack pupae are available for purchase and release.
- **Cultural/Mechanical Control:** Prevention is the best cure, so try to improve sanitation. Get rid of or spread manure, wet straw, and spoiled grain weekly to destroy breeding sites. Traps consisting of vertical white panels, which simulate animal legs, plus bait that releases carbon dioxide should be placed less than 30 inches above the ground. These traps will attract flies that can then be killed with flypaper or an electrocuting grid. Place one trap every 20 to 30 ft. around the perimeter of the fly-breeding area.

Arachnids

Mange Mites, *Sarcoptes scabiei* var. *suis* and *Demodex phylloides*

Of the two mange mites that affect swine, *S. scabiei* var. *suis* is the most common. These burrowing mites begin their infestation on the inner part of the ear and spread over the head, neck, and body. These mites have an eight- to 25-day life cycle but are present year-round and can survive for one to two days off the host in warm bedding. After mating near the skin surface, females dig tunnels in which they lay one to five eggs per day over a two-week period. The mite eggs hatch in three to 20 days and reach adulthood five days later. Adult females live only one month. Mange caused by *Demodex phylloides* is rare in swine. When these mites do occur, they occupy the hair follicles and cause pimple-like lesions, which may become infected and lead to abscesses. The life cycle from larva to adult takes approximately three weeks, and adults may live for up to two months.

- **Monitoring:** *Sarcoptes* mite infestations appear as raised areas covered with brown scabs, which fall off to reveal thickened, rough skin. Mild to intense itching may be observed in affected swine. Mite activity escalates with an increase in environmental or body temperature, which may lead to more irritation and itching. Producers usually notice the problem in winter due to the additional stresses of cold weather. As the pigs huddle to stay warm, the mites can be more easily spread. *Demodex* mite infestations first appear on the face, particularly around the nose and eyelids, and then move on to the abdomen and inner thighs. Itching is not typical with *Demodex* mange mites.
- **Chemical Control:** Once a herd is free of mange mites, chemical applications can be avoided by practicing good biosecurity and preventing the introduction of infested swine. Chemical treatments should focus on sows and herd boars to prevent the spread of mites to the pigs' offspring. Sows should be treated before farrowing, while boars should be treated four to six times per year. Examine hogs 30 days after treatment. If they still have mange, retreat. If another 30 days pass and they are still infested, cull the animals for carrier status. The Virginia Pest Management Guide recommends sprays (amitraz 12.5%, fenvalerate 10%, phosmet 11.6%, permethrin 11%); pour-ons (amitraz 2%); and injectables (ivermectin 1%; Ivomec for mange mites *Sarcoptes scabiei* var. *suis*). See the *Chemical Arthropod Control* section below for more information.
- **Biological Control:** None are currently recommended.
- **Cultural Control:** Practice good biosecurity measures to prevent the introduction of mites to a healthy population by way of infested pigs, feeder pigs, or breeding animals. Isolate new animals until they can be treated for diseases and pests.

Ticks, *Boophilus*, *Amblyomma*, and *Ixodes* spp.

Although both hard and soft ticks can be pests of hogs, only the hard ticks are a source of concern. This is primarily because they stay on the host for long periods and take large blood meals. Soft ticks feed only for short periods while the animal is resting. Ticks tend to be most problematic when pigs are allowed to roam in or near wooded areas. At worst, tick bites may cause inflammation, itching, and swelling. Ticks are not considered serious pests of swine.

- **Monitoring:** No specific monitoring protocol is recommended.
- **Chemical Control:** The Virginia Pest Management Guide recommends using amitraz (12.5%). See the *Chemical Arthropod Control* section below for more information.
- **Biological Control:** None are currently recommended.
- **Cultural Control:** Prevent swine from roaming near wooded areas.

CHEMICAL ARTHROPOD CONTROL

The following recommendations come from the Kelly Registration Systems Pesticide Database for Virginia and the 2008 Virginia Pest Management Guide (PMG).

- **Amitraz** (*Tactic* 12.5EC) – Amidine
 - For control of mange mites, lice, and ticks (*Sarcoptes scabiei* var. *suis* and *Haematopinus suis*), mix one can (760 mL = 25.7 oz.) in 50 gal. water (0.5 oz. per gal. spray solution). Apply as a coarse spray at 70-150 psi, spraying walls, floors, and fittings in pen. Spray all animals at the same time, whether affected or not. Spray to the point of runoff, with particular attention to jowls, legs, inside of ears, and underside of body. Make a second treatment 7-10 days later if treating for mites, and 10-14 days later for lice. Before application, remove feed from pen and cover drinking bowls. Remove and destroy bedding. Hose out feces and excess feed. Pre-slaughter interval = 3 days. Do not treat animals more than four times annually.
 - Virginia PMG recommends a 2% pour-on for control of lice and mange mites. Restrain animals and apply proper dosage, using a dosing gun according to label directions, to inside of each ear and along midline. Pre-slaughter interval = 7 days. Retreat in 7-10 days, if necessary.
- **Calcium Polysulfide** (*Lime Sulfur Solution* 29SC) – Inorganic
 - For control of mange mites, use as directed.
- **Chlorpyrifos** (*Duratrol Darkling Beetle Spray Microencapsulated* 20%) – Organophosphate – **RESTRICTED USE PESTICIDE**.
 - For use in enclosed/open swine premises. See the label for more information.
- **Coumaphos** (*Co-Ral* 11.6EC) – Organophosphate – **RESTRICTED USE PESTICIDE**.
 - For control of lice on swine, mix 2.5 fl. oz. in 4 gal. water. Apply spray to animals to point of runoff.
 - Virginia PMG recommends using coumaphos 25% for control of lice. Mix 2 lbs. product per 100 gal. water and apply to point of runoff.
 - Virginia PMG also recommends using coumaphos 1% dust for control of lice. No more than 1 oz. should be applied per animal, and not more than once every 10 days.
 - (*Prozap Zipcide*) – Apply directly to animals for control of flies and lice, or use in a dust bag.
- **Fenvalerate** (*Ectrin* 10WDL) – Pyrethroid
 - Virginia PMG recommends this for the control of lice and mange mites. Mix 1 qt. product in 50 gal. water and wet entire animal with up to 8 oz. spray. Pre-slaughter interval = 1 day.
- **Ivermectin** (*Ivomec Injectable* 1%) – Macrocyclic Lactone
 - For control of gastrointestinal roundworms, lungworms, lice, and mange mites in swine, inject 1 mL per 75 lbs. body weight into the neck, behind the ear. Pre-slaughter interval = 18 days.
- **Malathion** (*Malathion* 57EC) – Organophosphate

- For control of flies around livestock houses, apply a spray containing 2 gal. product per 100 gal. water. Apply spray at a rate of 1 gal. per 1,000 sq. ft. on painted surfaces, and 2 gal. per 1,000 sq. ft. on unpainted surfaces where flies congregate. Repeat as necessary. For use as a bait spray, use 2 gal. product with 2 gal. unsulfurized molasses or corn syrup, or 20 lbs. sugar per 100 gal. water. Use 3 gal. product with 40 lbs. sugar per 100 gal. water if fly population is severe.
- PMG recommends using malathion 4D for control of lice. Apply to all animals in herd and to pens. One treatment is sufficient. Avoid contaminating food and water.
- **Permethrin** (*SwineGuard Pour-on for Swine* 10%) – Synthetic Pyrethroid
 - For control of mange mites and lice and to aid in control of biting and nuisance flies on swine, use 3 mL per 100 lbs. weight (pint container) or 2.5 mL per 85 lbs. weight (gallon container). Apply across back of head and ears, and then apply down midline of neck and over shoulders. Apply to swine 100 lbs. and over. Repeat as necessary, but not more than once every two weeks. Two treatments administered 14 days apart give optimal control. Pre-slaughter interval = 5 days.
 - (*Ectiban* 5.7EC) – For control of lice and mange mites, use 2.5 tbsp. per gal. water and thoroughly soak animal, especially the ears. Repeat at 14-day intervals for control of mange. Spray walls and change bedding, also.
 - (*Gardstar* 40EC) – For control of lice and mange mites on swine, apply at a rate of 60-118 mL (a.i. = 0.026%-0.05%) per 25 gal. water to treat 50-100 swine. Thoroughly wet animals, including ears. For mange control, spray pen floors, sides, and bedding. Repeat at 14-day intervals. Pre-slaughter interval = 5 days.
 - (*Permethrin* 3.2EC) – For control of flies, cockroaches, mosquitoes, and spiders, apply 1 gal. per 750 sq. ft. surface. Retreat as necessary, but not more than once every 2 weeks. Do not apply directly to livestock or manure, and avoid contaminating food or water.
 - (*Atroban* 11EC) – PMG says follow label directions. For use on lice and mange mites on swine, add 1 pt. to 25 gal. water (3 tbsp. per 2.5 gal.) or 1 qt. to 50 gal. water (6 tbsp. per 5 gal. water) and thoroughly wet animals with spray, including ears. For mange, repeat at 14 day-intervals. Pre-slaughter interval = 5 days. For control on swine premises, mix 1 pt. with 10 gal. water (3 tbsp. per gal.) or 1 qt. to 20 gal. water (6 tbsp. per 2 gal.) and spray to the point of runoff, or 1 gal. per 750-1,000 sq. ft. For an overhead space spray system, mix 1 pt. to 10 gal. diesel or mineral oil (3 tbsp. per gal. oil) or 1 qt. to 20 gal. diesel or mineral oil (6 tbsp. per 2 gal.) at a rate of 4 oz. spray per 1,000 cu. ft. of air space. Remove animals before treatment, and thoroughly ventilate premises before reoccupying.
 - (*Permethrin* 0.25D) – PMG recommends applying 1 oz. (3 tbsp.) on head, shoulders, and neck for control of lice. Repeat as necessary, but not more than once every 10 days. Avoid contamination of water and feed via chemical storage or disposal. Keep container sealed when not in use.

- **Pyrethrins** (*Pyganic Crop Protection II 5EC*) – Botanical Pyrethrin
 - For control of biting and sucking lice on hogs, dilute at a rate of 1 qt. per 60 gal. water (1.5 fl. oz. per 2 gal. water) and spray to thoroughly wet animal hair, including head and tail. Repeat in 10 days to kill newly hatched lice.
 - (*Dairy Bomb 55*: Pyrethrins 0.5%, PBO 1%, Octacide 1%) – For use in hog operations, close all windows and doors, and apply for 1-2 seconds per 1,000 cu. ft. Keep area closed for 15 minutes after application. Or, apply a direct spray over backs of animals and spray for 1-2 seconds per hog. Do not spray directly on face or into eyes. Repeat daily or as necessary.
- **Phosmet/Imidan** (*Starbar Prolate/Lintox-HD Insecticidal Spray & Backrubber 11.75EC*) – Organophosphate
 - For control of sarcoptic mange and lice on swine, use 1 cup product per 6.25 gal. water. Not for use on sick or stressed animals, or suckling pigs. Reapply 14 days later, if necessary. However, usually a single treatment is effective. Pre-slaughter interval = 1 day.
- **Sulfur** (*Microfine Sulfur 90D*) – Inorganic
 - To control fleas and ticks, dust the animal liberally and rub into its hair. To treat bedding quarters, apply 200-250 lbs. per 20,000 sq. ft. as a spray (25-50 lbs. per 100 gal. water). Force spray into cracks and crevices to gain maximum control. Repeat as necessary.
- **Tetrachlorvinphos/Gardona** (*Rabon Oral Larvicide 7.76G*) – Organophosphate
 - For prevention of fecal flies in the manure of treated swine, administer 1.3 lbs. product per ton of feed and offer free choice. Equivalent to 22.7 mg product per pound of feed. All swine should be treated. For sows, boars, and breeding gilts, mix 2.5 lbs. per ton of feed and offer 4.8 lbs. feed per day. Equivalent to 45.4 mg product per pound of feed.
 - (*Rabon 50WP*) – For control of lice on swine, use 0.5 lb. product per 6 gal. water and apply as a coarse spray. Use 1-2 qts. per animal, applying to the point of runoff. Repeat 2 weeks later, if necessary. There is no pre-slaughter interval. Do not apply this product near or let it drift to blooming plants when bees are foraging.
 - (3% Dust) – Virginia PMG says for control of lice, apply 3-4 oz. per animal. Repeat as necessary, but not more than once every 14 days. When dealing with severe infestations, treat animals and bedding. Use 1 lb. per 150 sq. ft. of bedding.

DISEASE PESTS

Brief descriptions of some common diseases follow. However, their treatment is not the focus of this document because vaccines and antibiotics are not usually considered state-regulated pesticides. Do not rely on the following suggestions to control suspected diseases in swine. Please consult a veterinarian to determine the most current and effective treatment options.

Swine are vulnerable to many infectious diseases. Currently, the most important illnesses are porcine reproductive and respiratory syndrome (PRRS) and porcine circovirus

associated diseases (PCVAD). In Virginia, if swine are suspected of having the following diseases, it must be reported within 24 hours: African swine fever, brucellosis (*Brucella suis*), classical swine fever (hog cholera), Nipah virus encephalitis, swine vesicular disease, and trichinellosis (*Trichinella spiralis*). There are far too many swine diseases to list here. Most fit into three classes: respiratory diseases (pneumonia or influenzas that cause coughing, sneezing, reduced gains, poor feed conversion, and are most troublesome at 18 to 20 weeks of age); enteric diseases (diarrhea or scours caused by *E.coli*, *Salmonella*, or *Clostridium*, which are the main causes of piglet mortality); and reproductive diseases (e.g., enterovirus, erysipelas, leptospirosis, PRRS, and porcine parvovirus, which cause small litters, spontaneous abortions, poor conception rates, and small piglets).

BACTERIAL PESTS

Diarrhea/Scours, *E. coli* spp., *Salmonella* spp., *Clostridium* spp., and others

Diarrhea, also known as swine scours, is a very serious illness in young pigs caused by several different types of bacteria. Piglets are most susceptible to contracting scours at three weeks of age, although they are also vulnerable in the first few days of life and when they are weaned. Stressful activities such as castration, vaccination, or deworming should not be scheduled during any of these vulnerable periods, especially not at three weeks of age. Sow's milk contains antibodies that confer immunity to the baby pigs, but this works only if they feed on the colostrum soon after birth. Once pigs are four to five weeks old, they have already developed their own antibodies.

- **Monitoring:** No specific monitoring protocol is recommended. Colon/fecal samples may be submitted to diagnostic laboratories for identification of the particular bacterial source of the infection.
- **Chemical Control:** Consult a veterinarian for disease identification and current treatment options.
- **Biological Control:** No biological control agents are recommended.
- **Cultural Control:** Practice good sanitation. Make sure the rearing environment is dry, warm, and draft free.

Erysipelas, *Erysipelothrix rhusiopathiae*

Erysipelas occurs in three forms: acute, subacute, and chronic. Acute symptoms include depression, high fever, lack of appetite, muscle stiffness, lameness, lethargy, and rapid death. Also, pigs may squeal when any amount of pressure is applied to their bodies. The skin of the ears, snout, jowl, and belly may be discolored, which is commonly seen in blood infections. Additionally, high fevers may cause gravid sows to abort. Subacute infections are similar to acute, but milder. Pigs may have fevers, but they are not as high or as long lasting. The heart and joints may be chronically inflamed or visibly swollen,

and animals may have trouble getting up and walking. Heart lesions may be observed after slaughter. However, most economic damage is caused by the chronic form, which leads to arthritis and heart inflammation. Arthritic lesions result in reduced growth and more carcass trim at slaughter. “Diamond-skin disease” lesions are unique to erysipelas and are caused by bacteria residing in capillaries, which kill diamond-shaped patches of skin. These bacteria can also be found in the tonsils, intestine, and manure. Up to half of swine are silent carriers of erysipelas. The most likely way for healthy animals to contract erysipelas is through soil contaminated by infected feces.

- **Monitoring:** No specific monitoring protocol is recommended. Although it is difficult to conclusively diagnose this disease, the diamond pattern on the skin is unique to erysipelas. Also, an injection of penicillin will control symptoms in 24 to 36 hours.
- **Chemical Control:** Consult a veterinarian for disease identification and current treatment options.
- **Biological Control:** No biological control agents are recommended.
- **Cultural Control:** Practice good sanitation, and keep swine off infected soil, if possible.

VIRAL PESTS

Classical Swine Fever (Hog Cholera)

Classical swine fever, or hog cholera, is a highly contagious disease that was eradicated in the United States in 1978 after 16 years of effort. Since then, outbreaks have occurred in the Caribbean and Europe. This disease manifests itself in three forms: acute, chronic, and mild. The acute condition causes fevers as high as 107°F, convulsions, loss of appetite, and the tendency to huddle together. Afflicted hogs will typically die within one to two weeks. The chronic form causes similar, but less severe, symptoms along with red rashes on the ears and legs. Infected hogs may battle the disease for three to four months before succumbing to the virus. Mild cases of hog cholera manifest as brief periods of illness followed by recovery, but a fatal relapse will eventually occur. This disease also causes smaller litters, stillborn piglets, and other reproductive failures. Also, there will be high mortality at weaning. Transmission occurs via pig-to-pig contact; bodily fluids; infected equipment, feed, and clothing; wild birds; insects; humans; and food wastes containing untreated pork scraps.

- **Monitoring:** Check animals twice a week for odd symptoms or behaviors.
- **Chemical Control:** No chemical controls are recommended.
- **Biological Control:** No biological controls are recommended.

- **Cultural Control:** Virginia law requires that food be heated to proper temperatures in garbage feeding settings to limit virus transmission, although very few market hogs are fed in this manner. Grain-based feed does NOT need to be heated. Keep new hogs separate from the herd for at least three weeks, quarantine sick hogs until a diagnosis is made, and maintain secure fencing to keep wild pigs away. Practice good biosecurity by wearing clean clothes and footwear. Also, use clean equipment, facilities, and vehicles.

Foot-and-Mouth Disease

No cases of the highly contagious foot-and-mouth disease (FMD) have been recorded in the United States since 1929, although Europe has had several outbreaks in recent years. Symptoms include fever, blisters, and sores in the mouth, on the teats, and between the hooves. Animals have the potential to recover, but there may be permanent side effects. The virus is concentrated in lymph nodes and bone marrow, and can survive outside the host for up to one month depending on temperature and pH. The virus can be killed by exposure to a liquid with an acidic pH less than 6. Foot-and-mouth disease is spread by people, animals, infected materials, clothes, equipment, vehicles, raw meat fed to animals, infected bedding, artificial insemination, and contaminated water. Other symptoms include loss of appetite due to oral lesions, excessive salivation, and lameness. There is no cure for FMD, and infected animals are slaughtered to reduce the risk of spreading the disease.

- **Monitoring:** No specific monitoring protocol is recommended. Report any suspected cases of FMD to a local veterinarian or to the State Veterinarian's Office.
- **Chemical Control:** A vaccine exists but is used only to treat animals at farms surrounding an infected farm.
- **Biological Control:** No biological controls are recommended.
- **Cultural Control:** Keep animals healthy and practice good biosecurity measures. New animals should always be quarantined before allowing them to mingle with the general population. Animal transport vehicles should be cleaned thoroughly before reentering the farm. Swine should not be fed raw garbage. Farm visitors should be asked if they have had any recent contact with livestock and must wear clean clothing and shoes before entering the farm. The USDA is recommending that persons visiting a country with FMD not visit farms from five days before their departure from the foreign country to five days after reentering the United States. Clothes should be washed before returning to the United States and rewashed upon arrival. Shoes should also be thoroughly disinfected. Foreign animal products such as meat, dairy, and raw fiber products should not be brought back from overseas visits.

Porcine Reproductive and Respiratory Syndrome (PRRS)

Porcine reproductive and respiratory syndrome was first described in the United States in 1987. This disease can lead to abortions in breeding sows, respiratory problems, and mortality in entire litters of newborn piglets. Older pigs, such as those in nurseries, may die or grow more slowly due to poor feed-to-growth conversion. Economic losses amount to approximately \$110 to \$240/female, and treatment costs are around \$1.75/pig.

- **Monitoring:** No specific monitoring protocol is recommended.
- **Chemical Control:** Consult a veterinarian for disease identification and current treatment options.
- **Biological Control:** No biological controls are recommended.
- **Cultural Control:** Keep animals healthy and practice good biosecurity measures.

Porcine Circovirus Associated Diseases (PCVAD) (aka Postweaning Multisystemic Wasting Syndrome-PMWS)

This complex of diseases causes weight loss at six to eight weeks of age, along with thinning, rough hair, and pale skin. Mortality ranges from 6% to 20%, with an economic loss of \$6/pig in producer-finisher enterprises. Other diseases included in this complex are pneumonia, systemic infection, reproductive failure, and porcine dermatitis and nephropathy syndrome (PDNS). There are several different strains of PCVAD, and all swine have some form of the disease. Porcine circovirus 1 has been detected in American herds for decades. Porcine circovirus 2 is virulent and is a major cause of mortality. However, some swine remain asymptomatic, although virus-shedding lesions may be present. Porcine circovirus 2b, or European PCV2, is more common in outbreaks in U.S. swine. Porcine circovirus 2a, or North American PCV2, may also be pathogenic. Disease transmission occurs via mucous membranes through pig-to-pig contact. The virus is shed in secretions and excretions over long periods. It is unclear if semen and artificial insemination are also potential sources of infection.

- **Monitoring:** No specific monitoring protocol is recommended.
- **Chemical Control:** Currently, there is a preventive vaccine that appears to give good results and cuts mortality in half. Consult a veterinarian for disease identification and current treatment options.
- **Biological Control:** No biological controls are recommended.
- **Cultural Control:** Vaccinate swine for other diseases and practice good biosecurity measures by changing footwear/coveralls and washing hands between groups, particularly when contacting healthy animals after visiting sick swine.

NEMATODE, FLATWORM, AND PROTOZOAN PESTS

Pigs may contract many different kinds of internal parasites, the most common being large roundworms. Nodular worms, whipworms, lungworms, stomach worms, threadworms, and kidney worms may be problematic as well. However, with the exception of toxoplasmosis, which is a significant health concern to pregnant women, this document will not describe the pest management strategies for the various internal parasites of swine. Treatment involves using dewormers that are prescribed by veterinarians or are available over the counter, and thus are not state-regulated pesticides.

Swine Toxoplasmosis, *Toxoplasma gondii*

Toxoplasmosis is a widespread protozoan parasite that infects both swine and people who eat insufficiently cooked pork. Cats are the definitive hosts for this disease, contracting oocysts from infected prey. The cats then excrete oocysts in their feces, which may be contracted by humans during litter box cleaning. Oocysts survive for months and are resistant to many disinfectants. Once ingested, they infect muscles, the liver, the brain, and other tissues. Toxoplasmosis infection is especially dangerous in pregnant women, who can pass it on to their fetus, thus resulting in miscarriage or an infected child. Fifteen percent to 25% of pigs have been exposed in the United States, but most do not usually fall ill. In swine, this disease most often manifests itself in nursery piglets that are either born sick or dead (sometimes mummified), or fall ill within three weeks of birth. Some, however, are completely healthy. The most common symptom is respiratory distress, but fever, lethargy, diarrhea, neurological problems, and blindness may also be evident. Approximately 40% of adults in the United States are infected, unknown to them because no clinical signs are present. However, the effects on human fetuses can be very serious, including retardation, blindness, and birth defects. Unfortunately, sometimes these effects are delayed for up to 20 or 30 years! Fetuses of women already exposed to toxoplasmosis before pregnancy are not at risk for health problems.

- **Monitoring:** Toxoplasmosis can be identified through a blood test. Dead piglets should be submitted for necropsy to determine cause of death.
- **Chemical Control:** No chemical controls are recommended.
- **Biological Control:** No biological controls are recommended.
- **Cultural Control:** To prevent infection in swine, do not use cats to control rodents. Cats should be kept away from swine barns and feed/water sources. Also, remove dead pigs and either destroy them immediately or have their bodies necropsied. Uncooked garbage should never be fed to pigs. Oocysts are destroyed when heated to 152°F or held at 12°F for 24 hours. Irradiation with 100 krad cobalt or cesium is another effective means of destroying this protozoan pest.

DISEASE CHEMICAL CONTROL

Vaccines and antibiotics are not considered state-regulated pesticides. Please consult a veterinarian or the 2008 Pork Industry Handbook (Purdue University Extension - www.ces.purdue.edu/extmedia/AS/PIH_Order_Form_2008.pdf) for more information on treating any of the aforementioned diseases.

VERTEBRATE PESTS

Rats and Mice

Rats and mice are important pests of swine facilities because they cause structural damage, chew holes in food containers, consume and contaminate feed, and vector diseases. The species causing the greatest problems include house mice, Norway rats, and roof rats. Norway rats can destroy foundations and concrete slabs, while roof rats and house mice severely damage insulation. Wiring may also be destroyed, causing fires and power outages, which are very dangerous if swine are housed indoors. Rodents spread disease in their feces, fur, urine, saliva, and blood. Healthy pigs may contract diseases from sick pigs due to the movement of rodents, or by eating dead, infected rats and mice. In addition, predatory wild animals are attracted to swine buildings by the presence of rodents. Mouse nests are typically established in walls and ceilings, while rats prefer to dig underground burrows next to building walls.

Although rodents tend to be mainly nocturnal, they may be seen during the day when populations are large. House mice are approximately 6 inches long from nose to tail, with brown or gray fur, big ears, and little eyes. Norway rats are over a foot long including the 7-inch tail, with red or gray-brown fur and gray or yellowish white sternum. Roof rats are slightly smaller than the Norway rats and have black or gray fur with gray-white sternums. The roof rat's tail is longer than its head and body combined, and it has a more pointed nose. Also, the eyes and ears are larger than the Norway rat. Rats consume copious amounts of grain, bugs, meat, and trash. Meanwhile, house mice eat only small amounts of food, but their tendency to gnaw feed sacks and their ability to vector diseases cause the greatest economic losses. Another difference between rats and mice is that rats need free access to standing water. Mice, on the other hand, can get by without water for long periods because they can acquire it through food alone. Mice complete their life cycle from birth to reproductive maturity in just six to ten weeks. Gestation lasts approximately three weeks after mating. The typical life span for rodents is nine to 12 months.

- **Monitoring:** Rodent activity should be monitored at night. Rodent infestations are evident by the presence of feces, burrows, nests made of paper and/or other fiber, paw tracks, fresh gnaw marks, and travel pathways. Traps should be used to determine population density and treatment threshold.
- **Chemical Control:** Control existing populations using poisons or fumigants. See the *Vertebrate Chemical Control* section for more information. Control must be maintained once the rodent population is knocked down, so permanent bait stations

should be installed in buildings and around perimeters with fresh bait added regularly to control new pests. Monthly monitoring should be in effect after control is achieved. Look for and remove dead, poisoned rodents to keep pigs and other predators from eating the remains and dying. Use rubber gloves, tongs, and lots of newspaper to properly dispose of bodies. Old, uneaten bait should be removed and disposed of properly as well.

- **Biological Control:** Although rodents have many natural enemies, none provide adequate control. If cats and dogs are used to control rats and mice, more than likely the rodents will continue to proliferate and take advantage of the pet food left out for the “rat-catchers.”
- **Cultural Control:** In short, reduce refuge sites, reduce clutter and garbage, keep feed in rodent-proof containers, make structures rodent proof, initiate or escalate control measures when evidence of rodents is obvious, use traps to knock down large populations, and place traps where rodents are active until success is achieved. Once the problem is under control, continue monthly maintenance efforts with permanent stations. Traps work well when trying to control small populations; larger populations usually require the use of poisons. Mice are easy to trap, but rats are smarter and thus harder to catch and kill. Traps are good control options because no poison is used, which not only reduces the risk of nontarget poisonings but also makes it easier to determine precisely how many rodents have been exterminated. Poisoned rodents tend to die in hard-to-reach areas, which may cause an odor problem as well. Snap traps can be baited with peanut butter and oats, bacon, meat, or cheese. Traps should be baited but left unset at first to reduce trap shyness. They should be placed in dark spots or behind objects with the trigger next to the wall because rodent pathways tend to be where they feel most secure. Flour or talc can be spread around to determine rodent pathways. Traps should be located not more than 10 ft. apart, and should only be used for two to three weeks at a time, followed by inactive periods to prevent trap shyness. It is especially important to place traps on either side of suspected entry points. Keep records of how many rodents are trapped in each location to determine the trapping efficacy.

Another option for catching mice (not rats) is the use of glue traps. However, these can be dangerous if wildlife, pets, or children encounter them. If dust is an issue in the swine facilities, glue boards should be placed in bait stations or otherwise protected from contamination. It is exceedingly difficult to repel rodents when livestock feed is so attractive, but removing shelter for hiding, sleeping, and nesting can help somewhat. Dispose of debris, and remove weeds in a 3-ft. swath around the building perimeter. Feed should be stored in rodent-proof rooms or containers. Although sound and electronic devices are repellent initially, rodents quickly become desensitized. Ultrasonic devices are ineffective because they are directional and do not travel around objects. Feed sacks should be stacked on pallets with sufficient room around the piles to place traps and monitor for activity. All holes more than a quarter inch wide should be temporarily sealed with steel wool or permanently closed using concrete, galvanized sheet metal, brick, hardware

cloth, or aluminum. Plastic, wood, and rubber will not work because rodents can easily chew through those materials. Close entry points around wires and pipes with mortar or metal collars. Rodents gain easy access to swine houses by way of the unprotected end of corrugated or ribbed metal siding. It is best to attach metal siding directly against the sill plate or foundation. Doors and windows must fit tightly or be surrounded by metal to keep rodents out. To discourage digging near the foundation, gravel can be laid around the building perimeter in a 1-inch-diameter barricade that is 2 ft. wide and 0.5 ft. deep. Lay half-inch hardware cloth in an L-formation (with the bottom of the “L” being 12 inches long and facing away from the building) at a depth of 12 to 18 inches.

VERTEBRATE CHEMICAL CONTROL

Rodenticides are also very toxic to humans. Use extreme caution when applying these chemicals, and be sure to completely follow all label directions. Avoid placing rodenticides where animals or children may contact them.

Non-anticoagulants

These are excellent for use in anticoagulant-resistant rodents. Non-anticoagulants are also good for controlling large populations of rodents in locations where more attractive food items exist, making it hard to get them to take bait. However, these are much more dangerous if accidentally consumed by pets, humans, or livestock. This is because non-anticoagulants work faster (within 12 hours to 4 days) than anticoagulants and are harder to counteract with first aid.

- **Bromethalin** (*Clout All Weather Bait*) – Benzenamine
 - For *bait control* of rats on agricultural premises, place 2-12 baits at 20- to 30-ft. intervals. For control of mice, place 1-2 baits at 8- to 12-ft. intervals. Maintain bait supply for at least 1 week, or until rodent activity ceases.
 - Bromethalin affects the central nervous system and takes only a small amount to kill. Rodents usually feed once and die.
- **Cholecalciferol** (*Rampage*) –
 - For *bait control* of rats on agricultural premises, place 2-8 packs at 15- to 30-ft. intervals. Maintain uninterrupted supply of fresh bait for at least 10 days. For control of mice, place 1 pack at 8- to 12-ft. intervals. Maintain an uninterrupted supply of fresh bait for at least 15 days.
 - Cholecalciferol is made from vitamin D₃, which is toxic in large amounts. Rodents take one large meal or several small meals and die soon after.
- **Zinc Phosphide** (*Eraze Rodent Pellets*) – Inorganic
 - For *bait control* of rodents on agricultural premises, follow label directions.
 - Zinc phosphide is a black powder that has a garlic odor. Sublethal doses may cause bait shyness. This product should not be used in the same location more than twice per year. Zinc phosphide is less commonly used today because more effective options are available. Prebaiting helps make zinc phosphide more effective.

Anticoagulants

These chemicals are used in 90% of baits and cause massive internal hemorrhaging. Death occurs in 3-7 days. Rodents will not exhibit bait shyness because these compounds are slow acting, and the pests fail to associate illness with their feeding on poison. Anticoagulants may either take several feedings to work or may start poisoning the rodents immediately. These poisons are less dangerous to humans and swine, and are readily accepted by rats and mice. Complete eradication of rodents is possible with anticoagulants, but non-anticoagulants are not usually as effective. Thus, anticoagulants work well as a secondary product to finish off surviving pests. If rodents develop resistance, then single-dose products or non-anticoagulants should be used. Poisons are usually purchased as loose grain baits or as pellets contained in plastic or paper packets. The rats gnaw into these packets. For maximum efficacy, only fresh baits should be used. For rats, ensure that bait stays in the burrows to encourage feeding. Anticoagulants in wax form are helpful in spots that are damp where grain-based poisons would become moldy and spoil. Always keep poison baits away from areas where swine can reach them. To mix your own formula, canary grass seed makes an excellent base for mouse poison since it is preferred over hog feed or other grains. One can also make liquid bait, which is very attractive to rats, especially if water is not plentiful. However, mixing baits is much more dangerous than simply distributing ready-to-use formulations. Baits should be placed close to refuges and must be closer than other food sources so as to outcompete them. The optimal spacing for bait stations is 6-8 ft. for mice and 25-50 ft. for rats, or directly in their burrows. Bait boxes are worth using because they keep moisture, pets, children, and livestock from contacting poison. They must be big enough to hold several rodents at a time with two rodent-sized holes (0.5 inch for mice or 2.5 inches for rats). They should be labeled clearly with appropriate warning language. It is recommended that they be attached to the floor or the wall to avoid tipping and spilling the contents.

- **Brodifacoum** (*D-Con Bait Pellets II*) – Anticoagulant Rodenticide
 - For *bait control* of rats on agricultural premises, place 4-16 baits per placement at 15- to 30-ft. intervals. For control of mice, place 1-2 baits per placement at 8- to 12-ft. intervals. Maintain bait supply for 10-15 days, or until rodent activity ceases.
- **Bromadiolone** (*ROC-622 Rat & Mouse Bait Packs*) – Anticoagulant Rodenticide
 - For *bait control* of rats on agricultural premises, place 3-10 packs per placement. For control of mice, place 1 pack per placement. Maintain bait supply for 10-15 days, or until rodent activity ceases.
- **Chlorophacinone** (*RoZol*) – Anticoagulant Rodenticide
 - For control of rats on agricultural premises, apply at the rate of 2 oz. powder per 2.5 sq. ft. of runway area. For control of mice, use 1 oz. per 2.5 sq. ft. of runway area. Rodents will pick up powder on their feet and fur and ingest it through grooming. Maintain powder in treated areas for at least 20 days.
- **Diphacinone** (*Ramik Green Mini Bait Packs*) – Anticoagulant Rodenticide
 - For *bait control* of rats on agricultural premises, use 3-10 packs per placement. For control of mice, use 1-2 packs per placement, spaced at

8- to 12-ft. intervals. Maintain bait supply for 10-15 days, or until rodent activity ceases.

- **Difethialone** (*D-Con Rat & Mouse Bait Blocks*) – Benzothiothiopyranone
 - For *bait control* of rats on agricultural premises, place 6-23 blocks per placement, spaced at 15- to 30-ft. intervals. For control of mice, apply 1 or 2 blocks per placement, spaced at 8- to 12-ft. intervals. Provide an uninterrupted supply of bait for 10-15 days, or until rodent activity ceases.
- **Warfarin** (*Ra-Mo-Cide WF*) – Anticoagulant Rodenticide
 - For *bait control* of rats, use 2-5 packs per placement, providing a supply of bait for at least 10 days. For control of mice, open the pack and apply 0.25-0.5 oz. of bait at 8- to 12-ft. intervals.

Fumigants

Used to control Norway rats in tunnels, fumigants are typically only utilized in grain storage buildings or warehouses. They are very toxic to nontarget organisms, so only licensed structural pest control operators should apply these chemicals.

- **Aluminum Phosphide** (*Weevil-Cide Pellets*) – Inorganic – **RESTRICTED USE PESTICIDE**.
 - For control of rodents on agricultural premises, follow label directions.

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ONLINE RESOURCES

Journal of Animal Science, <http://jas.fass.org/>

Journal of Swine Health and Production, www.aasp.org/shap.html

National Pork Board, www.pork.org

National Swine Registry, <http://www.nationalswine.com/>

(The) Pig Site, www.thepigsite.com

Porcine Circovirus Type 2, www.pcv2.org

Pork Information Gateway (PIG), www.usporkcenter.org

PORKNET, www.porknet.com

Virginia Agricultural Statistics Service, <http://www.nass.usda.gov/va>

Virginia Department of Agriculture and Consumer Services, www.vdacs.virginia.gov

Virginia Department of Environmental Quality – Agriculture,
www.deq.virginia.gov/vpa/agriculture.html

Virginia Pest Management Guides, www.ext.vt.edu/pubs/pmg

Virginia Tech Pesticide Programs, www.vtpp.org

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