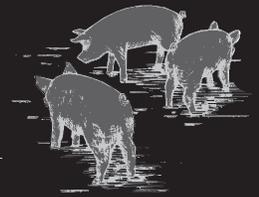


# Sprinkling Oil to Reduce Dust, Gases, and Odor in Swine Buildings



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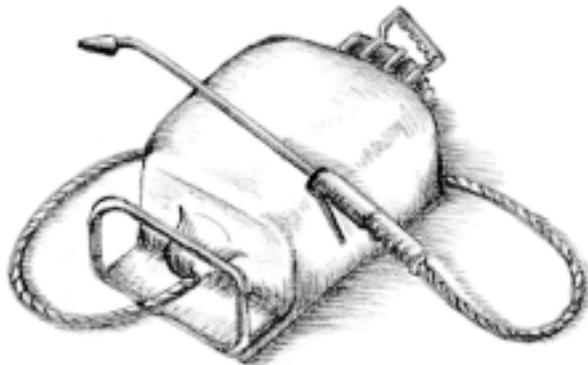
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Pork producers have identified the indoor environment as one of their highest concerns within the industry, citing it as one of the adverse factors in recruiting and maintaining qualified people to work in swine facilities. Producers frequently name air quality problems as prime causes for high employee turnover in the swine production industry. Clearly, efforts to improve air quality in swine facilities are critical to the future of the pork industry and to the safety of farm owners and employees.

Research in the United States, Canada, and Europe has confirmed that people working in pig barns have a much higher risk of developing respiratory diseases than do other types of workers in rural communities. Most sources agree that dust, especially respirable dust which is smaller than 5.0 microns ( $\mu\text{m}$ ) in diameter, is primarily responsible for these health risks.<sup>1, 2, 3, 4, 5</sup>

This publication presents emerging technology that could be useful in helping diminish health risks to those employed in the swine industry, thereby contributing to a safer future for farm owners and employees. It describes research done to reduce dust and odor, explains the results of that research, and identifies oil sprinkling rather than oil spraying as a method by which the average swine producer can effectively reduce dust and odor in swine buildings.

The material presented here shows that a producer could sprinkle oil on a regular schedule and reduce modified respirable dust by approximately 80% and inhalable dust in the air by approximately 85%. For these improved conditions in an operation marketing 4,000 pigs per year, estimated costs are approximately \$1.14 per pig marketed. Of the total cost, 70% is for labor.



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## A Need to Improve Working Conditions

Dust is one of the biggest problems in swine buildings. The dust to be most concerned with in swine buildings falls into four categories: Respirable dust, Modified respirable dust, Inhalable dust, and Modified inhalable dust.

*Respirable dust.* In this publication, total dust refers to all of the actual dust in the air, while respirable dust refers to the dust with particle sizes smaller than 5.0 microns ( $\mu\text{m}$ ). Because dust with particles this size can penetrate into respiratory tracts and lungs, it is called respirable dust. Respirable dust is a primary cause of respiratory problems.

*Modified respirable dust.* Modified respirable dust is respirable dust excluding particles smaller than 0.5  $\mu\text{m}$ . Thus, it is a measure of dust with particle sizes of 0.5 to 5.0  $\mu\text{m}$ . Particles smaller than 0.5  $\mu\text{m}$  are not a big concern in swine buildings because particles this size primarily are from outside air.<sup>8</sup>

*Inhalable dust.* Inhalable dust is the dust a respiratory system or a measurement device can inhale. Because of the limitations of the instrumentation, for example the sampling efficiency of optical particle counters, the instrument can measure only the dust it can inhale not the actual amount of dust in the air. Thus, the dust the instrumentation can measure is called inhalable dust. Particles collected by a human nose are a good example of inhalable dust.

*Modified inhalable dust.* Inhalable dust excluding particles smaller than 0.5  $\mu\text{m}$  is called modified inhalable dust. It is a measure of dust with particle sizes of 0.5  $\mu\text{m}$  and larger.

Another big problem in swine buildings is with odors. When manure is stored in a building, anaerobic conditions develop quickly within the manure. The result is odorous, irritating, and potentially toxic gases. Gases can contribute to respiratory problems for pigs and humans.

### Past Solutions

A popular practice to reduce dust in swine buildings is to add 1% to 2% of oil or fat to the feed. While adding oil or fat to the feed is effective in reducing the feed dust particles larger than 5.0  $\mu\text{m}$  in diameter, the practice is not effective in reducing respirable particles less than 5.0  $\mu\text{m}$  in diameter.<sup>6</sup> These smaller particles often are manure materials, micro-organisms, and pig skin flakes<sup>7</sup> and are a primary cause of health risks because particles of

this size can penetrate deeply into the respiratory systems of humans and animals.

Another way to make working conditions in swine facilities more tolerable is to use a dust respirator, but a dust respirator provides benefit only to the user, not to the animals in the room. Unless dust respirators completely seal around the face, they can be a less-than-effective method of reducing dust and odors being breathed. Dust respirators that do fit well can be difficult and uncomfortable to breathe through. Also, not all dust respirators can filter out respirable dust. Additionally, dust respirators do not help control the amount of dust in the air and do not help improve air quality. Because of these factors, some people prefer not to wear dust respirators and look to other methods for relief from the dust in the air.

### A New Solution: Sprinkling Oil

Recent studies have demonstrated that sprinkling a small amount of oil in swine facilities can reduce dust and gas concentrations substantially.<sup>8,9,10</sup> A one-year experiment at the Prairie Swine Center in Canada used two swine grow-finish rooms as an experiment base. One room was used as a control and was not treated; the other received a daily oil treatment. The treatment consisted of sprinkling crude canola oil daily throughout the room in variable dosages that averaged 2 ounces per 100 square feet (6 milliliters per square meter) of floor area.

On average, this treatment reduced modified respirable dust by 81% and inhalable dust in the air by 85% (Figure 1). The dust level in the treated room was much lower than the threshold limits recommended by the American Congress of Government and Industrial Hygienists<sup>11</sup> and by agricultural experts.<sup>3</sup> In fact, the particle count in the oil-sprinkled swine room was reduced to a level similar to that found in office buildings.

Over the one-year experimental period, sprinkling crude canola oil also reduced, on average, hydrogen sulfide by 27% and ammonia concentration by 30% (Figure 2). As expected, the experiments produced little change in carbon dioxide concentration because carbon dioxide is primarily exhaled from animals, and the oil treatment would have little effect on it.

Air in the treatment room was perceived as having less odor than the air in the control room. Thirty-four visitors to the control and treatment rooms scored the treatment room as having significantly less

odor than the control room. On a scale of 7 (with 1 = strong in odor, 7 = no odor), the room sprinkled with oil scored 3.9, and the untreated room scored 2. The odor intensity was reduced by 50% according to the survey of these visitors.

The air quality difference between the oil-treated room and the untreated control room also could be observed visually. In the room with oil treatments, the air space appeared clear; while in the room without oil treatment, the air space appeared hazy. The air clarity levels were derived from survey data collected from the 34 visitors to the rooms during the experiment. On a scale of 7 (with 1 = very hazy, 7 = very clear), the treatment room scored 5.1, and the control room scored 2.9 for clarity of room air.

#### Benefits to human health

To determine if the research had effects on human health, 20 people who had never been exposed to swine environments did light exercise in three different spaces: a normal office, a properly sprinkled swine grow-finish room, and a non-sprinkled swine finishing room that served as a control for the experiment. Each subject spent one day in each room and exercised enough to simulate a barn worker's level of workload when he was in a swine room. The preset bike exercise was calibrated so that everyone would do the same amount of work. When not exercising, the subjects spent additional time in the rooms doing casual work.

Respiratory functions and white blood cell count were measured before and after the subjects were exposed to the conditions in the three rooms. Comparing the measurements revealed no significant difference between the results from the office and the oil-sprinkled room. However, results from the control room were significantly different from the results in both the office and the oil-sprinkled room.

Results from the control room showed that subjects experienced declines in respiratory functions and increases in white blood cell count. In particular, forced expiratory volume in one second (FEV1) of the human subjects declined 10% in the control room compared with 2% in the oil-sprinkled room. FEV1 is a measure of lung power, and a decline of FEV1 indicates a decrease in breathing efficiency.

Compared with the results from exposure to an office environment, the white blood count of the human subjects increased 42% in the control room compared with 3% in the oil-sprinkled room. White blood count is an indicator of how hard one's immune

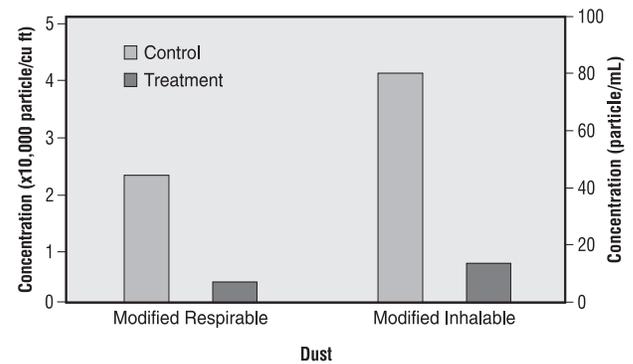


Figure 1. Effect of oil sprinkling on dust concentrations. Data are the means of three treatments in a one-year experiment in two identical swine grow-finish rooms.

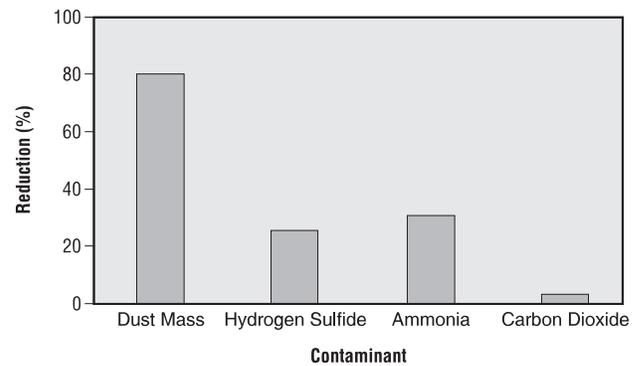


Figure 2. Effect of oil sprinkling on gas concentrations. Data are the means of three treatments in a one-year experiment in two identical swine grow-finish rooms.

system fights against alien pathogens. A higher white blood count indicates the body's immune system is fighting harder.

These human health results are from the acute responses of a relatively small population. Since the subjects in the study were never exposed to a swine environment before, they tended to be more responsive to the enclosed swine facility used in the test. It is not conclusive yet that oil sprinkling will prevent lung dysfunction in swine workers, but initial results are promising. The effect of the oil sprinkling technology on chronic response and lung functions of swine workers needs a long-term study on a larger population before definitive conclusions are possible.

#### Benefits to animal health

Lung lesions of 72 pigs from the treatment and control rooms (36 pigs from each room) were examined. There was no significant difference between lung lesions of pigs in the treatment group and the control group, neither was there a significant

difference in pig performance between the groups. No abnormal behavior or respiratory symptoms of pigs were reported throughout the experiment, and sprinkling oil had no observed adverse effect on the pigs' health. How much oil sprinkling improves animal health needs further study. It is fair to say that with improved air quality in barns, animal well being could be improved.

### Using Oil Sprinkling

The term *sprinkle* means that the oil is applied under low pressures and gives a shower-like effect. *Spray* means that the oil is applied at high pressure and gives a fog-like effect. Compared to the technology developed in Europe, which sprayed an oil-water mixture (95% water, 5% rape seed oil) at high pressure (2,350 psi),<sup>12</sup> sprinkling pure oil at low pressure has at least three advantages over spraying:

- (1) No water is added to the oil, thus, no moisture is added to the barn air space. This feature is particularly important for cold climate swine housing because the cost of extra ventilation for moisture control is a major concern in the heating season.
- (2) No aerial oil mist occurs because the oil is sprinkled at a low pressure (30 psi). Therefore, there appear to be no harmful effects on workers' health.
- (3) Simplified equipment design and low pressure reduce the cost of a sprinkling system.

### Which Oil Is Suitable?

Vegetable oils are recommended for this application because they are readily available, economical, and biologically safe to the animals. Crude canola, purified canola, flax, corn, sunflower, and soybean oil were tested in the laboratory. Results show all these vegetable oils are suitable for sprinkling in animal buildings. Due to slight differences in viscosity, the tested oils should be sprinkled at appropriate combinations of temperatures and pressures. The nozzle used in the tests was a fan type nozzle with an oval opening of 0.5 mm x 1 mm (similar to an 8003 or 11003 tip). This nozzle size range is common for commercial backpack sprayers.

Figure 3 shows the recommended temperatures and pressures for the six oils tested. If the sprinkling pressure is too high at a given temperature, the oil droplets may form an aerial mist which could be a health hazard. If the pressure is too low,

drizzling will occur, causing poor distribution of oil onto the floor area and low efficiency of dust reduction.

For example, crude canola oil (Figure 3a) should be sprinkled at 25 lbs/in<sup>2</sup> (psi) pressure or higher when oil temperature is 50 F (10 C), and only 17 psi pressure or higher is needed at 104 F (40 C). For all six oils, sprinkling at 30 psi will work in most barns where temperatures are in the range of 50 to 104 F (10 to 40 C).

Generally, oils do not need to be heated, but oils should be kept at about room temperature (60 to 70 F; 15 to 20 C) before sprinkling. If the oil is stored outside or in an unheated room in the winter, the oil should be brought to a heated room to allow the oil temperature to increase to room temperature before sprinkling. Sprinkling at an oil temperature lower than 50 F (10 C) may result in difficult sprinkling and poor dust reduction efficiency.

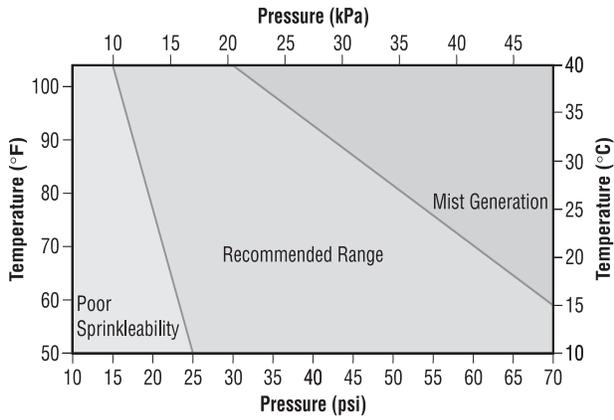
### Sprinkling Oil: How Much? How Often?

The experiments showed that sprinkling more oil does further reduce dust and odor. However, sprinkling too much oil may cause an oily environment and create a greasy residue on room surfaces such as floors and pen partitions. Therefore, the proper technique is to strike a balance between dust and odor abatement and an excessively oily environment.

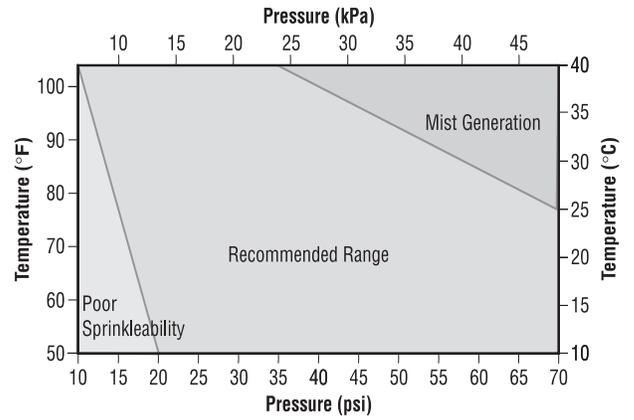
One way to help achieve that balance is to sprinkle more frequently. The experiments showed that with the same daily average dosage, sprinkling more often (e.g., once every day) is more effective than less often (e.g., once every other day). Sprinkling more often than once per day may not be practical because the amount of oil sprinkled would be too small.

Experiments also have shown that a variable oil application rate is more effective in reducing dust and odor and uses less oil than a constant oil application rate. A variable application rate means sprinkling different amounts of oil on different days, while a constant oil application rate means sprinkling the same amount of oil every day.

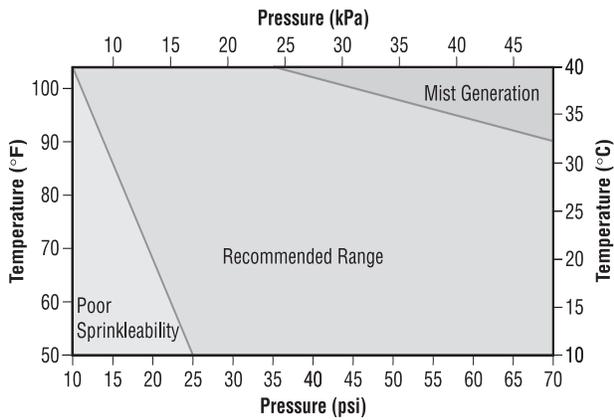
One tested formula for sprinkling oil in grow-finish rooms is shown in Table 1 and Figure 4. This schedule is to sprinkle 0.12 ounce/ft<sup>2</sup> (40 mL/m<sup>2</sup>) per day for the first two days; 0.06 ounce/ft<sup>2</sup> (20 mL/m<sup>2</sup>) per day for the second two days; and 0.015 ounce/ft<sup>2</sup>



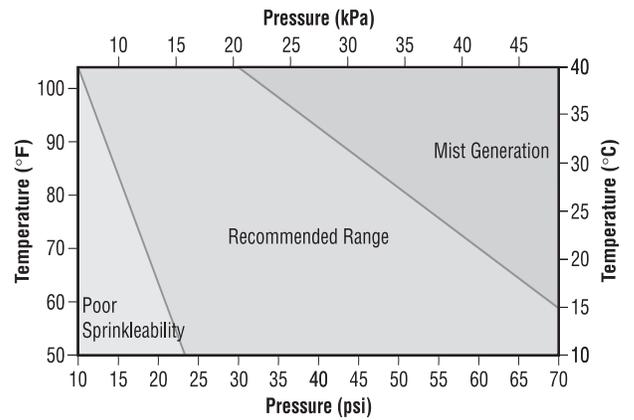
3a. Crude Canola Oil



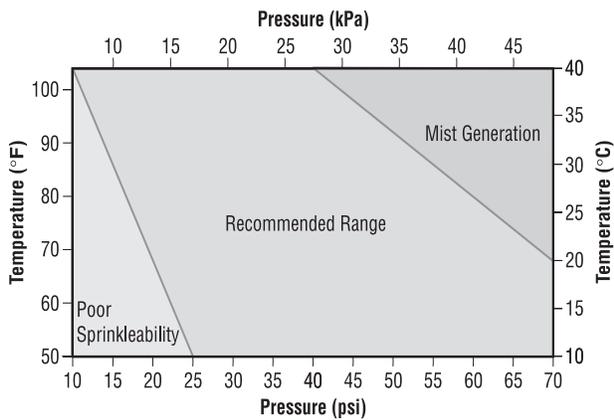
3b. Purified Canola Oil



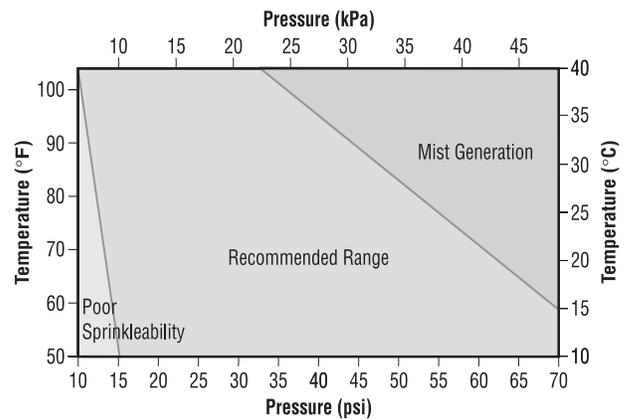
3c. Corn Oil



3d. Flax Oil



3e. Soybean Oil



3f. Sunflower Oil

Figure 3. Recommended temperatures and pressures at which oil is sprinkled. The shaded area at the lower left corners indicates poor sprinkleability, and the shaded area at the upper right corner indicates mist generation.

(5 mL/m<sup>2</sup>) per day for the remaining days in a sprinkling cycle. After each two weeks of 0.015 ounce/ft<sup>2</sup> (5 mL/m<sup>2</sup>) application, a 0.06 ounce/ft<sup>2</sup> (20 mL/m<sup>2</sup>) surge (one day application) might be needed to keep the dust concentration down (Figure 4). This surge is applied only once every two weeks.

Using this schedule reduced both respirable and inhalable dust concentrations more than 80% without creating greasy pens and walkways. Approximately two-thirds of a quart (0.6 liter) was used for each pig marketed, or 33 gallons per 1,000 square feet per year.

The recommended sprinkling schedule in Table 1 also can be used in farrowing and weaning rooms. Similar dust reduction was found when oil was sprinkled in those kinds of facilities. A rule-of-thumb is that the sprinkling rate should be reduced or even stopped when the surface appears wet (usually changes color). Periodic power washing is recommended for the rooms sprinkled with oil.

Using this schedule in all-in-all-out (AIAO) swine facilities during the experiments resulted in about 10% more time being spent on power washing the oil-sprinkled room than the control room. Since the amount of oil sprinkled is small, slipperiness is not a problem.

### How to Sprinkle

Other than sprinkling at the proper combination of temperature and pressure, the sprinkling process is fairly straightforward. The experiments at the Prairie Swine Center used a backpack sprayer with a pressure gauge commonly used for chemical spray. That device was found to be quite suitable. Both fan-shaped and circular nozzles provided good results.

Due to the small quantity of oil to be sprinkled over a large room floor area, the sprinkling process needs to be quick. It takes approximately three minutes to sprinkle a 2,000 square feet (180 m<sup>2</sup>) room.

Sprinkling should cover the entire floor area including sleeping and dunging areas, pig bodies, and operator walkways (Figure 5). Care should be exercised to minimize sprinkling on walls and pen partitions as oil residue can be hard to remove from these areas. In practice, sprinkling may not be uniform. When a spot on the floor appears oily, the spot should not be sprinkled.

During the sprinkling, the nozzle should be kept 30 inches (0.8 m) above the floor (about pen partition level). Sprinkling too far from the floor will cause

more oil to be sprinkled on walls or wall partitions. Holding the sprinkler too close to the floor may result in poor oil coverage on the floor area. When sprinkling using a backpack sprayer, the operator should periodically pump the sprayer to keep the pressure in the correct range.

Table 1. Recommended sprinkling schedule for AIAO swine buildings.

| Day                      | Application Rate                                | Oil needed to sprinkle a 42 x 48 ft room (12.8 x 14.6 m) |
|--------------------------|---|--|
| 1 and 2                  | 0.13 oz/ft <sup>2</sup> (40 mL/m <sup>2</sup> ) | 2 gal (7.6 L)  |
| 3 and 4                  | 0.06 oz/ft <sup>2</sup> (20mL/m <sup>2</sup> )  | 1 gal (3.8 L)  |
| 5 through 14             | 0.015 oz/ft <sup>2</sup> (5 mL/m <sup>2</sup> ) | 1 quart (0.9 L)  |
| 15                       | 0.06 oz/ft <sup>2</sup> (20 mL/m <sup>2</sup> ) | 1 gal (3.8 L)  |
| Every 2 weeks thereafter | 0.06 oz/ft <sup>2</sup> (20mL/m <sup>2</sup> )  | 1 gal (3.8 L)  |

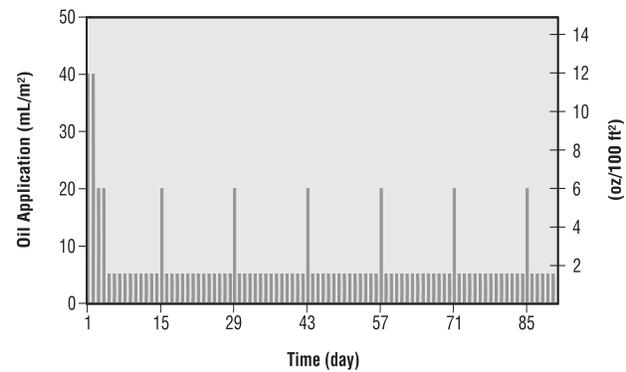


Figure 4. Recommended sprinkling schedule for AIAO swine buildings.



Figure 5. A backpack sprayer commonly used for chemical spray is quite suitable. The nozzle should be about 30 inches above the floor. Sprinkling should cover the entire floor area including sleeping and dunging areas, pig bodies, and operator walkways.

## Cost

The cost of the sprinkling equipment will vary depending on whether a manual or an automatic sprinkling system is used. The backpack sprinkler used in this study, for example, cost approximately \$120.

Using a variable sprinkling formula (e.g., a 0.12-, 0.06-, and 0.015-ounce/ft<sup>2</sup> (40-, 20-, and 5 -mL/m<sup>2</sup>) variable daily dosage as described above), consumes approximately two-thirds of a quart (0.6 L) per pig marketed for a grow-finish facility. The cost of oil sprinkled in this manner is much less than the typical cost of oil added into the feed for dust control. If the oil consumed as a feed additive is replaced by the same amount of nutrient-content feed, the oil sprinkling technology could reduce production costs.

For example, a feed ration with 1.5% oil represents 10 pounds of oil consumed by a market pig. If the 10 pounds of oil (about 3 gallons, \$6) were replaced by 30 pounds of feed with a similar amount of nutrients (approximately \$2), and two pounds oil (\$1) and two dollars of labor (two-thirds of the total cost for sprinkling) were used for sprinkling, the cost saving could be one dollar per pig marketed.

Assume a 200 farrow-to-finish swine facility, which produces 4,000 market pigs annually, has 20,000 square feet of total floor area. The total annual cost of sprinkling oil over the area using a backpack sprayer would be approximately \$4,560 (See Table 2). Most of the cost (two-thirds of the total cost) for oil sprinkling is from the labor. If the sprinkling were combined with daily inspection, labor costs could be minimized. With improved working environments in swine buildings, qualified stock persons could be retained, and workers' satisfaction could be enhanced. That could offset the labor cost of oil sprinkling.

Table 2. Annual cost of sprinkling a 20,000 ft<sup>2</sup> swine facility.

| Item   | Cost                       |
|--|----------------------------|
| Backpack sprayer                               | \$120                      |
| Oil, (660 gallons @ \$2/gal)                   | \$1,320                    |
| Labor: Person-hour to sprinkle, 360-hr, \$8/hr | \$2,880                    |
| Extra time for power wash, 30-hrs, \$8/hr      | \$240                      |
| <b>Total cost</b>                              | <b>\$4,560</b>             |
| <b>Cost per pig marketed</b>                   | <b>\$1.14/pig marketed</b> |

## Summary

Sprinkling oil to reduce dust and odors has been successful in several studies done at the Prairie Swine Center in Canada. The method of application was a daily sprinkling using a backpack sprayer, which may be the best choice for use in many small barns. The next step in developing this technology is to design an automated system with cost-effective automated equipment for sprinkling oil. Such a system might be most effective in large facilities. An automatic sprinkling system could be similar to, or incorporated with, an existing water sprinkling system for evaporative cooling. Conventional water sprinkling systems have an operating pressure of 30 psi, which is suitable for sprinkling rather than spraying oil.

## Acknowledgments and References

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