# Development Activity 2024-3 PRB2011-001SAX Diatomaceous Earth (DE) Application

## Objectives – (Question or information gap to answer)

A comparison of application methods to distribute diatomaceous earth (DE) throughout a silo. The aim of this development activity saw a range of application methods (dry form) compared in common silo sizes, to determine distribution uniformity of DE at all levels of the silo.

## Background

As a structural treatment for empty storages, DE controls storage pests that may not have been removed with physical cleaning methods. This ensures the storage is insect free prior to being filled.

Tools used to apply DE include the compressed-air venturi gun (BloVac gun). While the venturi gun has been considered an accepted method of DE application for many years, alternatives including battery and motor leaf blowers can potentially be used for application but have been previously untested. With increasing numbers of large flat bottom silos on farm testing of DE application methods in these structures also needed to be tested.

Dry-form DE typically requires air movement to distribute product throughout the storage, to achieve a uniform coating of all surfaces.

Application in sheds and large storages is alternatively achieved by mixing the dry form DE powder with water before spraying the slurry onto surfaces. This method is less favoured due to the time and equipment required for mixing and wear on pumps.

A flagged future development activity would utilise the method offering the most uniform application of dry DE application determined in this research, in a grain storage shed.

This research however focussed on cone base and flat bottom silos with a 120t cone base silo and a 1680t flat bottom silo selected for testing.

## Development Activity Methodology

Preliminary open-air testing was conducted to refine the selection of application methods, based on a visual appraisal of DE projection.

The BloVac brand venturi gun (See image 1) produced a very fine cloud of dust, but velocity was low. As a benchmark application method, it was included for testing in the 120t cone-base silo.

The 18v battery blower (See image 2) produced a consistent stream of fine dust forming a cloud so was included for testing in the cone silo. The home-made 50mm venturi used in combination with the 18v blower was tested in various configurations with a PVC “Y” fitting and suction pipe of roughly half that diameter, cut at 45 degrees producing the best balance of suction and airflow for delivery. (See image 6).

The 18v blower was also tested using two alternate delivery methods. Firstly, without the venturi but trickling the DE into the outlet airstream and secondly, introducing it into the suction side of the blower. Both of these methods demonstrated a tendency to release clumps of DE producing an inconsistent cloud of dust so were discounted.

The petrol-powered leaf blower (See image 3), fitted with a 75mm home-made venturi produced a very strong cloud of dust. Visually the strongest applicator, it was selected for testing in the cone silo and, pending confirmation, was selected as the most suitable option for testing in the larger flat bottom silo.

The garden duster in image 4 produced a very fine stream with low velocity resulting in a small cloud of dust and was subsequently discounted.



Image 1: BloVac BV22 Venturi Gun (Connected to an air compressor)




Image 2: Makita DUB185Z 18v battery blower with home-made 50mm venturi attached




Image 3: A Stihl BG56 petrol leaf blower with home-made 75mm venturi attached



Image 4: Garden duster on a Makita DUB185Z 18v battery blower

Distribution uniformity data was gathered by mounting a series of identically-sized trays on the internal walls of the silo to collect the dust distributed throughout the silo at a range of levels.

The trays were attached to PVC conduit, which was temporarily held to the silo wall with magnets. (See image 5A and 5B).

Three conduits with trays attached were spaced evenly around the silo at angle intervals of 120˚DE applied from the silo's ground access door intersecting two of the tray positions. (See images 7 and 8).

In the cone bottom silo, collection trays mounted to the conduits were mounted at four heights. The first positioned at the intersection of the cone base and wall section (0 meters), then vertically up the silo walls at 2m, 4m and 6m. (See Image 5A and Figure 1).

In the flat bottom silo, the three columns of conduit-mounted collection trays were vertically spaced at 2m starting at 0.8m from the floor then 2.8m, 4.8m, and 6.8m. In addition, a single conduit was hung from the centre inlet projecting into the silo with three trays attached. These trays were positioned at 9.2m from the floor, 11.2m and 13.2m. (See Image 5B and Figure 2).

According to the label, the application rate for DE is 2 grams per square meter, which for this trial equated to 0.29kg in the 120t cone bottom silo and 1.7Kg in the 1680t flat bottom silo.

Thirty to sixty minutes after a single application when the dust had settled, trays were carefully removed from the silo and weighed using Digitech digital scales with a resolution of 0.01g.



Image 5A: Securing trays on the wall of the cone bottom silo to measure distribution of application.

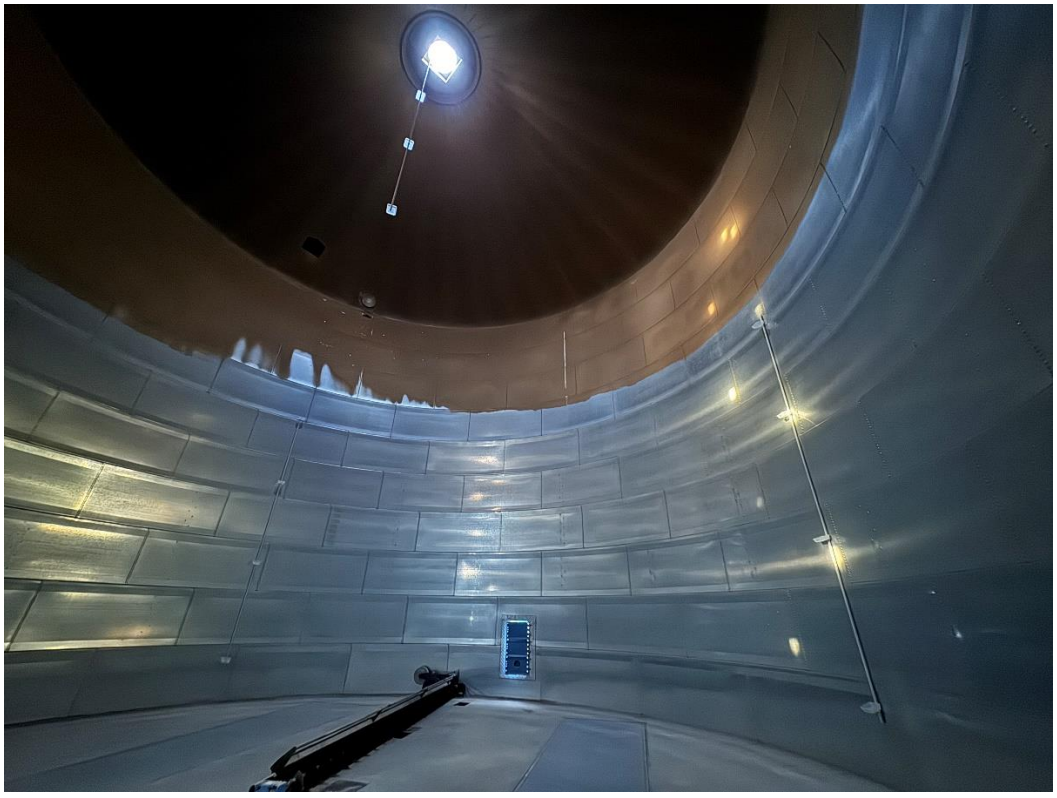


Image 5B: Trays secured on wall and hung from the top of the flat bottom silo to measure distribution of application.



Image 6: Home-made venturi was found to work best with a PVC “Y” fitting, with the suction pipe roughly half the diameter of the outlet, cut on a 45 degree angle to create an area of high and low pressure, based on Bernoulli’s principle.



Image 7: Application into the cone bottom silo via the access hole in the bottom.



Image 8: Application into the flat bottom silo via the ground level access door through the silo wall.

# Results

The mass of dust collected in the trays was sufficient to be assessed by weight and confirmed visually.

Weights collected in the trays indicated that regardless of application method, distribution around all walls of the silo was most even with a moving nozzle and airstream in all directions.

An initial test was repeated due the lack of nozzle movement during application resulting in an uneven distribution of product.

In all tests, weights recorded in each of the three locations around the silo were averaged. An analysis of the average weight at each height was then compared. More consistent weight at each height indicate superior distribution uniformity.

Perfect distribution uniformity would see 25% of the total mass collected in each tray at the four levels in the cone base silo. The flat bottom silo, having 7 trays between the top and bottom would have 14.3% of the total mass in each tray for perfect distribution uniformity.

**Cone base silo**

The compressed-air BloVac achieved low distribution uniformity with 50% of the total mass of captured product weighed being in the bottom tray and only 1% reaching the tray at the top of the silo wall (See Figure 1A).

There was no significant difference in distribution between the 18v battery blower and petrol leaf blower in the cone bottom silo. Measured mass in the bottom and 2m position trays was 34% and 32% respectively. This was approximately double that weighed in the top two trays at 14% and 16% respectively. Despite this top-to-bottom variation, the result was significantly more uniform than the result achieved with the BloVac.

**Flat bottom silo**

Petrol leaf blower application in the flat bottom silo can be seen in figure 2A which demonstrates a uniform distribution at all heights inside the silo. The largest measured mass range was between the middle height at 11% of the total and three other heights above and below weighing 16% each of the total.

**Observation of application time**

During the application testing, longer periods of time were taken (1-2minutes) to deliver the product with the 18v blower and petrol-powered blower due to the venturi design. The difference in delivery time potentially provided two distribution benefits over the BloVac (<1minute). Firstly, a slow and steady induction into the venturi was observed to result in less clumping during delivery, producing a finer cloud of dust floating throughout the storage. Secondly, running the blowers for a longer period maintained dust suspension and circulation inside the storage. This additional suspension time arguably provides an increased chance of DE reaching the upper areas of the silo rather than falling quickly to the silo floor.

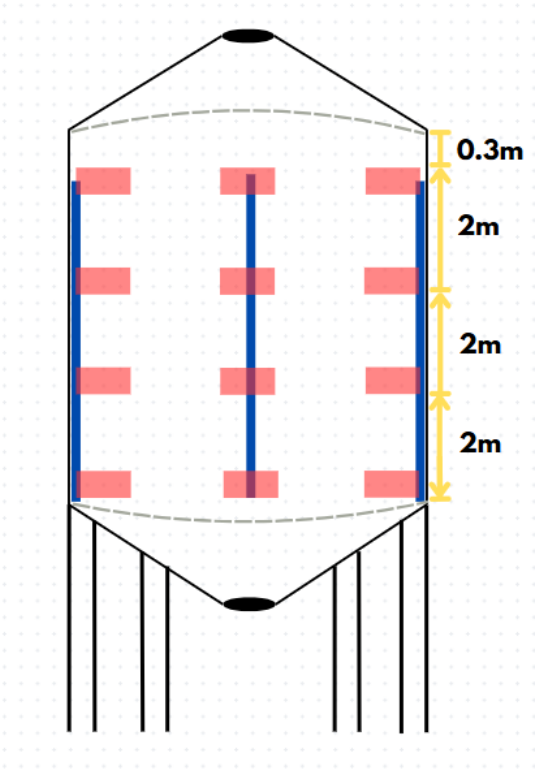



Figure 1: Layout of collection trays in cone bottom silo

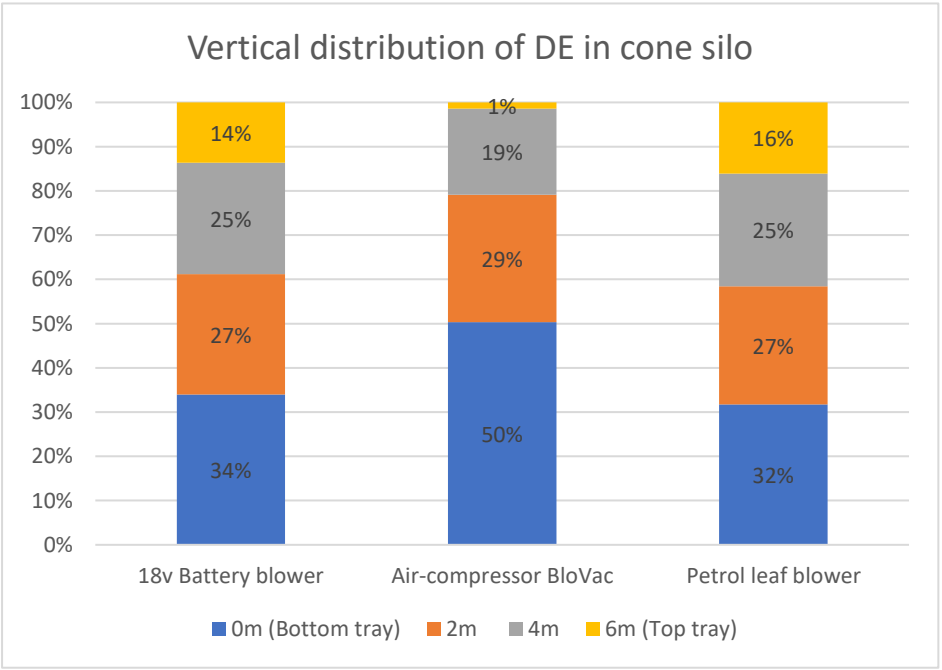



Figure 1A: Distribution results in cone bottom silo

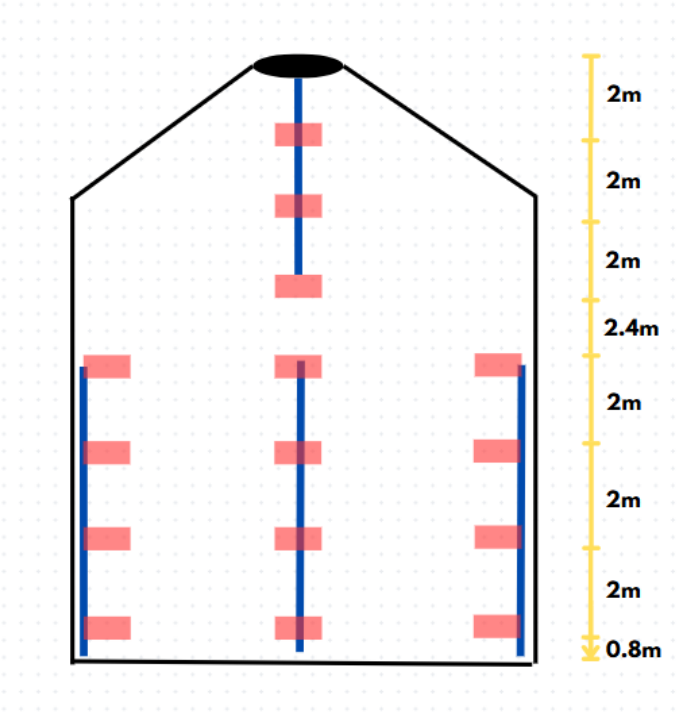



Figure 2: Layout of collection trays in flat bottom silo

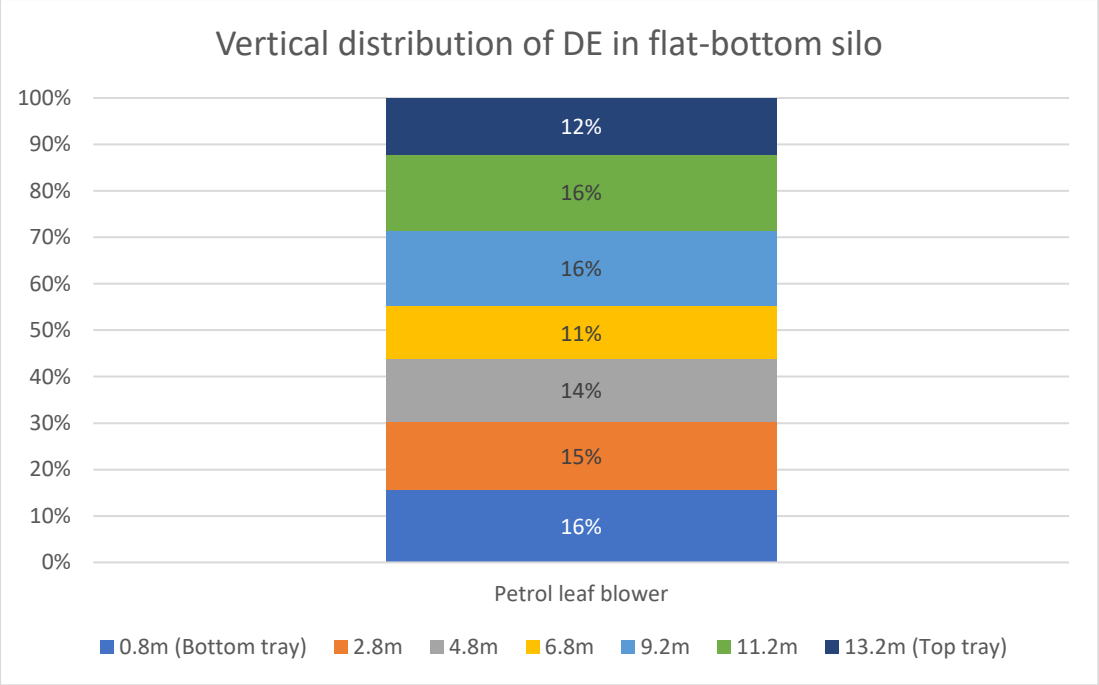



Figure 2A: Distribution results in flat bottom silo

## Outcome and Recommendations

Learnings based on these results:

- The 18v battery blower and petrol leaf blowers are recommended as they provided superior application distribution over the benchmark air-compressor BloVac gun.
- Even distribution was achieved in the flat bottom silo by applying through the access door at ground-level and is recommended. Ground-level application offers a safer method of DE dispersal by avoiding the need to apply via the top inlet or from inside the silo.
- Venturi induction, produces a finer, more uniform distribution of product over manually trickling DE into an airstream or via the suction side of a blower.
- Variation of the airstream by regularly directing the blower nozzle to all areas of the silo improves distribution around all walls.
- Application over a longer period maintains dust suspension. With circulation, this may assist achieving a more even distribution to all areas in the silo.
- If using a home-made venturi, a “Y” fitting and suction pipe half the diameter of the “Y” fitting achieved an optimal balance of suction and airflow.

Future work to strengthen this development activity could include:

- Repeating the trial with the two application methods achieving the highest distribution uniformity and vary application time and actions. (Vary how long the blower is circulating air in the silo and the direction the nozzle is pointed).
- Trial application methods in a grain shed to determine suitability to achieve consistently uniform coverage without operator exposure during application. The use of additional fans or through-draft may be needed for dust suspension and circulation throughout the shed.