Verifying Liquid Manure Hydraulic Distribution

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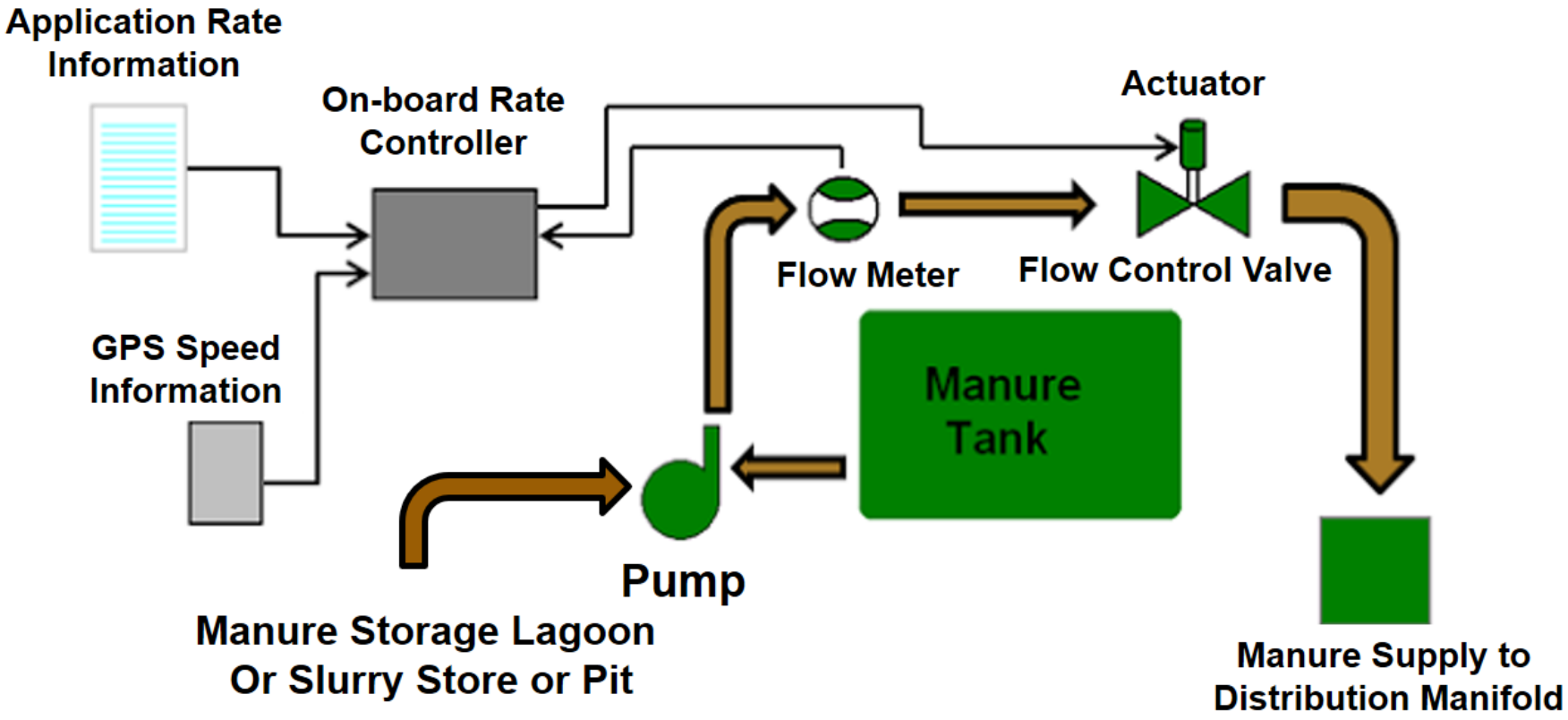


Figure 1. Diagram of on board control system used to set and control manure application rate

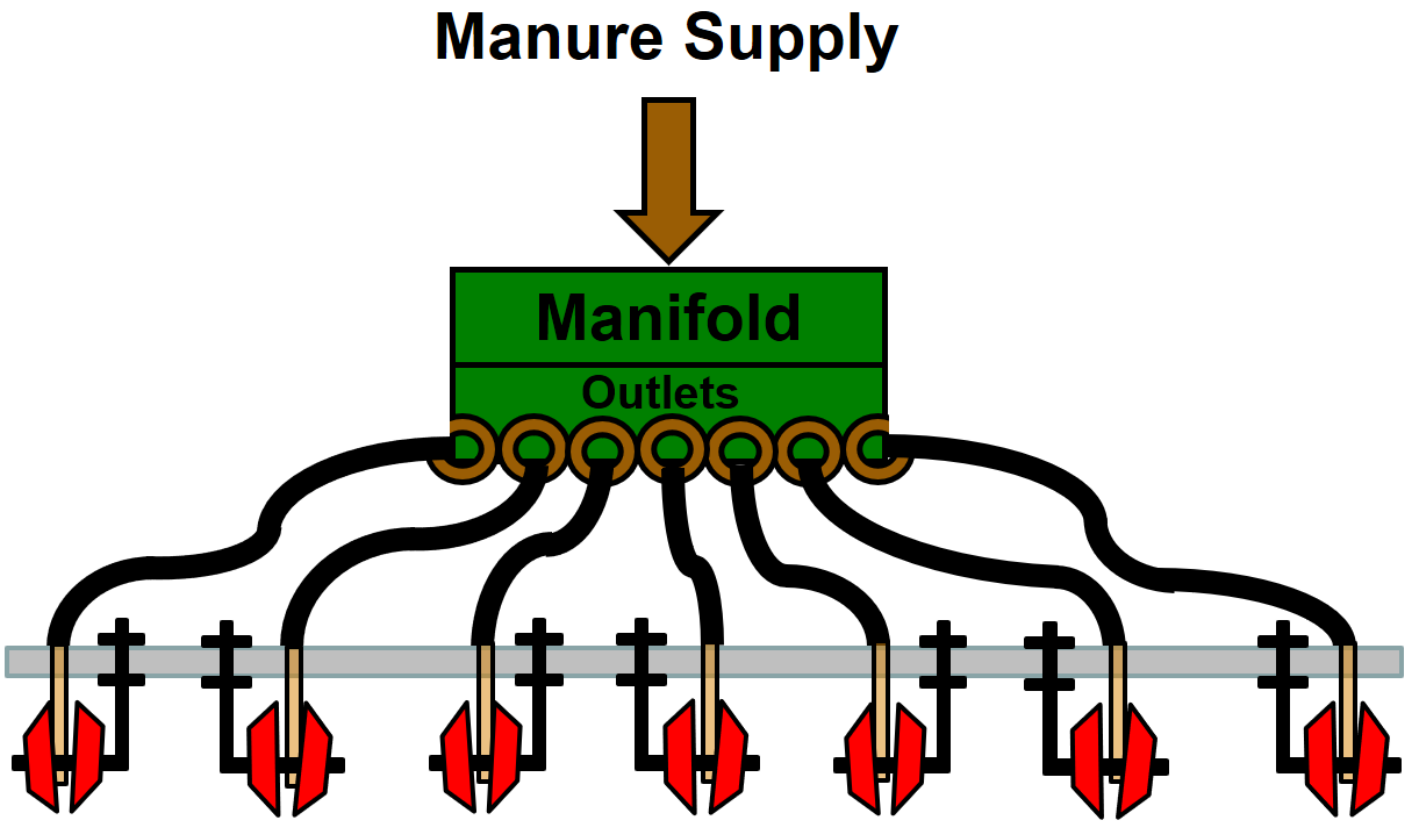


Figure 2. Dragline or tank-mounted manifold for distribution of liquid manure to tool-bar points.

Problem Statement

- Producer confidence in manure nutrient availability
- Poor distribution can lead one to believe that manure nutrients are not available leading to a decision for supplemental nutrients to be applied
- Need to verify distribution from a manifold

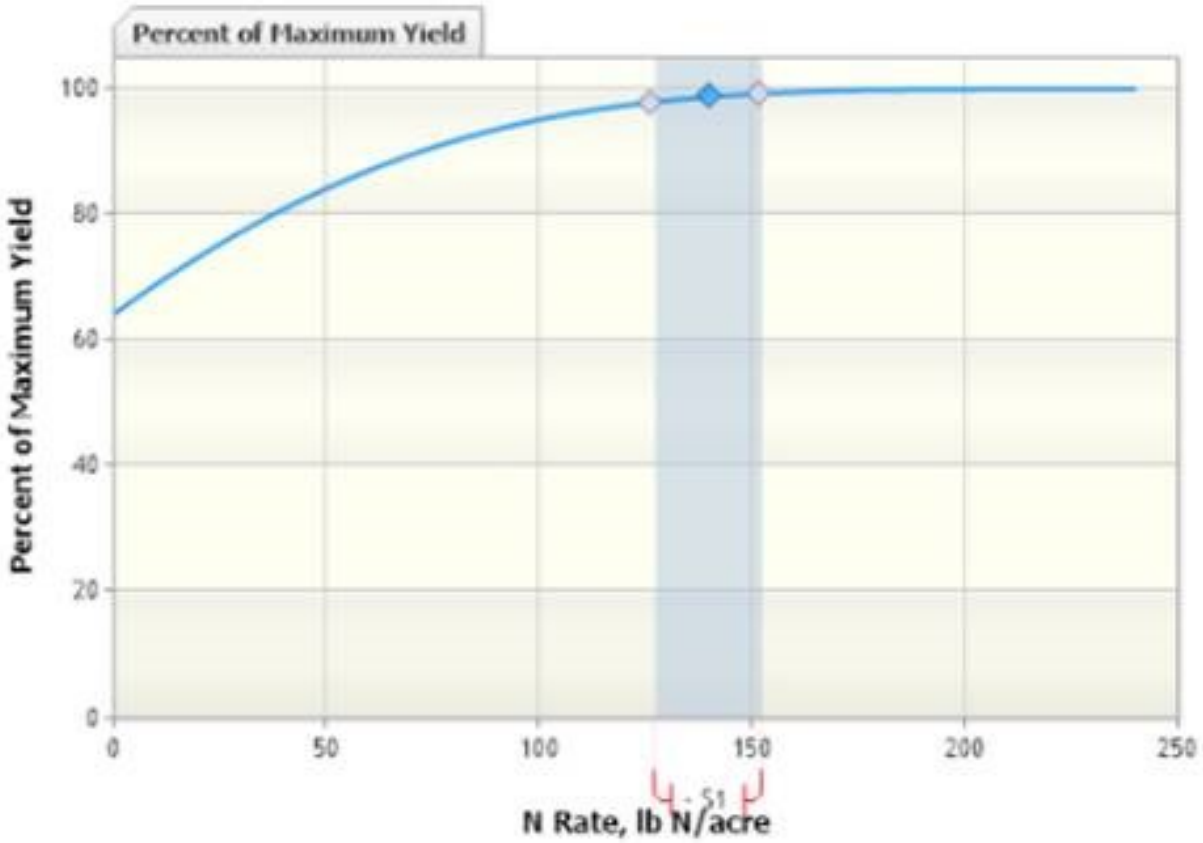
Area – Volume Calibration

- Calibrate to ensure manifold chamber is exposed to appropriate flow rate
- Know volume over a measured area
- AE 3601 (Revised version of PM 1948)
- Alternatively, convert application rate to flow rate, capture volume of liquid that is input into the manifold chamber over a know time

Distribution Variability

- How poor can this variability be?
- For low application rates, the manifold chamber is typically not pressurized
- Flow momentum and direction can potentially lead to variability
- Can some outlets not be discharging while others are discharging twice or three times the amount?

What's this mean to me?



Knife #	N Application (lb N/acre)	N Application (lb N/acre)
1	100	150
2	135	160
3	165	170
4	210	160
5	220	150
6	180	140
7	120	120
8	70	150
Average	150	150
St. Dev.	53	15
COV	35	10

But what's the impact?

Knife #	Corn Yield (CS) (bu/acre)	Corn Yield (CS) (bu/acre)	Corn Yield (CC) (bu/acre)	Corn Yield (CC) (bu/acre)
1	187	194	162	179
2	193	195	175	182
3	196	196	183	184
4	198	195	190	182
5	198	194	191	179
6	197	193	186	177
7	191	191	170	170
8	178	194	146	179
Average	**192**	**194**	**175**	**179**

Distribution Variability

- Why operate manifolds at low application rates?
- Split application
- Manure application to soybeans
- High total nitrogen manure analytical results
- Maximum Return to Nitrogen Rate Calculator

SAMPLE INFORMATION
LIQUID MANURE
Livestock Type: SWINE
Producer:
Sample ID: 1

RESULTS: Reported As Received
Site Name:
Site No:
Source:

ANALYTE	ACTUAL ANALYSIS		TOTAL NUTRIENTS	
Moisture, Total	90.6	%	N2 *	
Nitrogen, Total	0.91	%	76.0	lbs/1000 Gal
Phosphorus	0.44	% as P2O5	36.7	lbs/1000 Gal
Potassium	0.48	% as K2O	40.1	lbs/1000 Gal
Sulfur	1560	ppm	13.1	lbs/1000 Gal
Zinc	111	ppm	0.93	lbs/1000 Gal

Distribution Variability

- High total nitrogen manure analytical results
  - 70 lbs / 1,000 gallons
- Maximum Return to Nitrogen Rate Calculator
  - Nitrogen to Corn Price Ratio = 0.08
  - Nitrogen Rate = 141 lb/ac ±10%
- Can the variability of manure distribution be 10%?

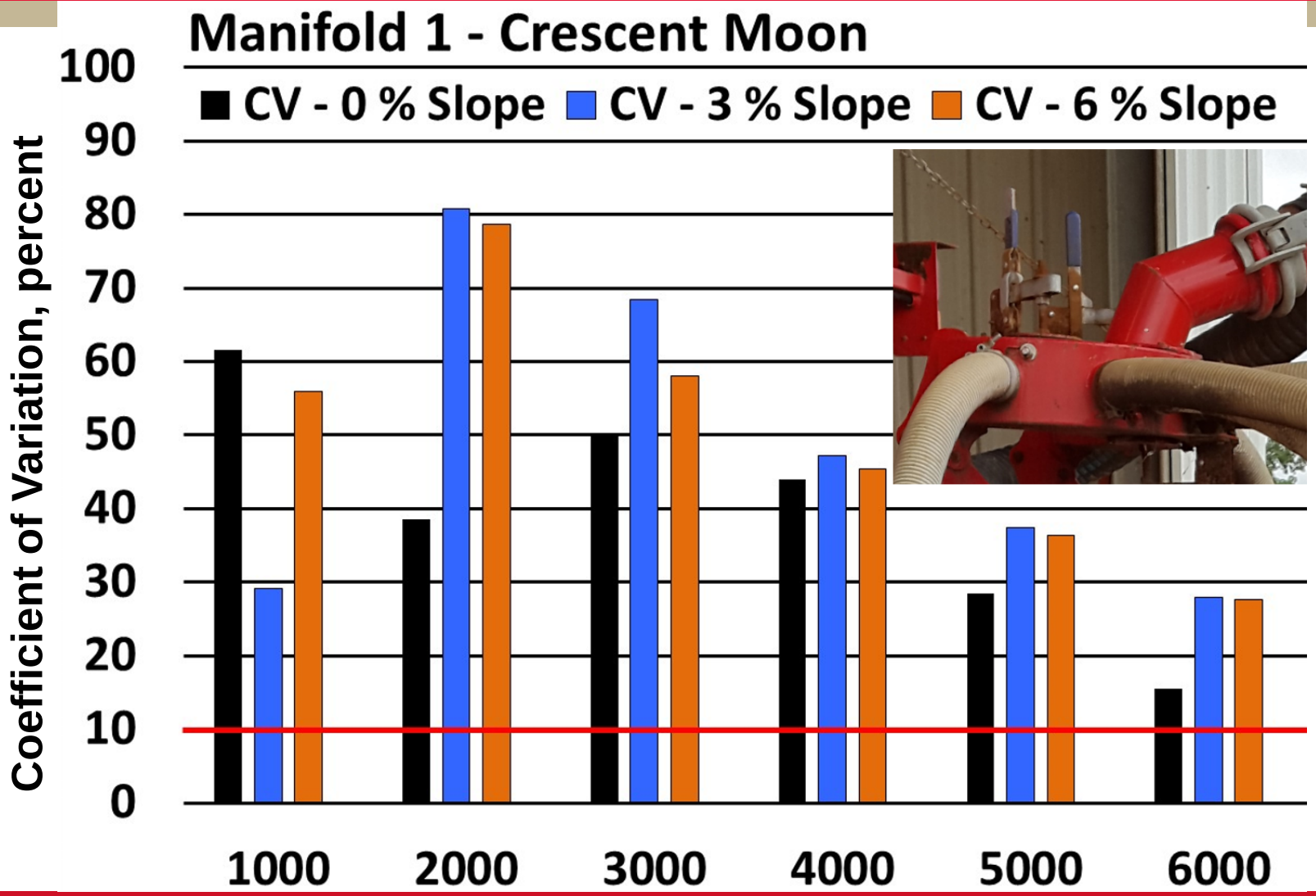
Verifying a Manifold

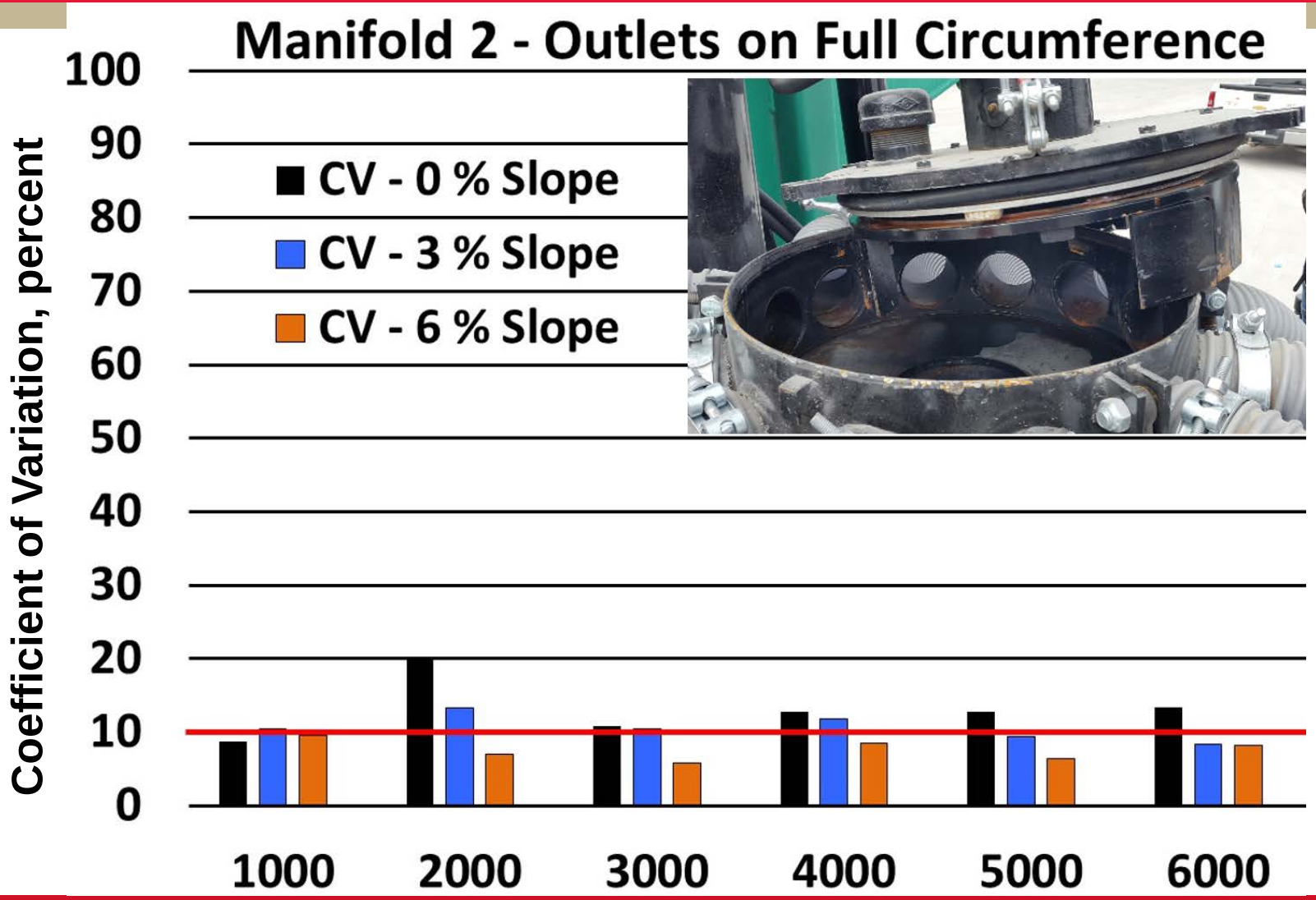
Verifying a Manifold

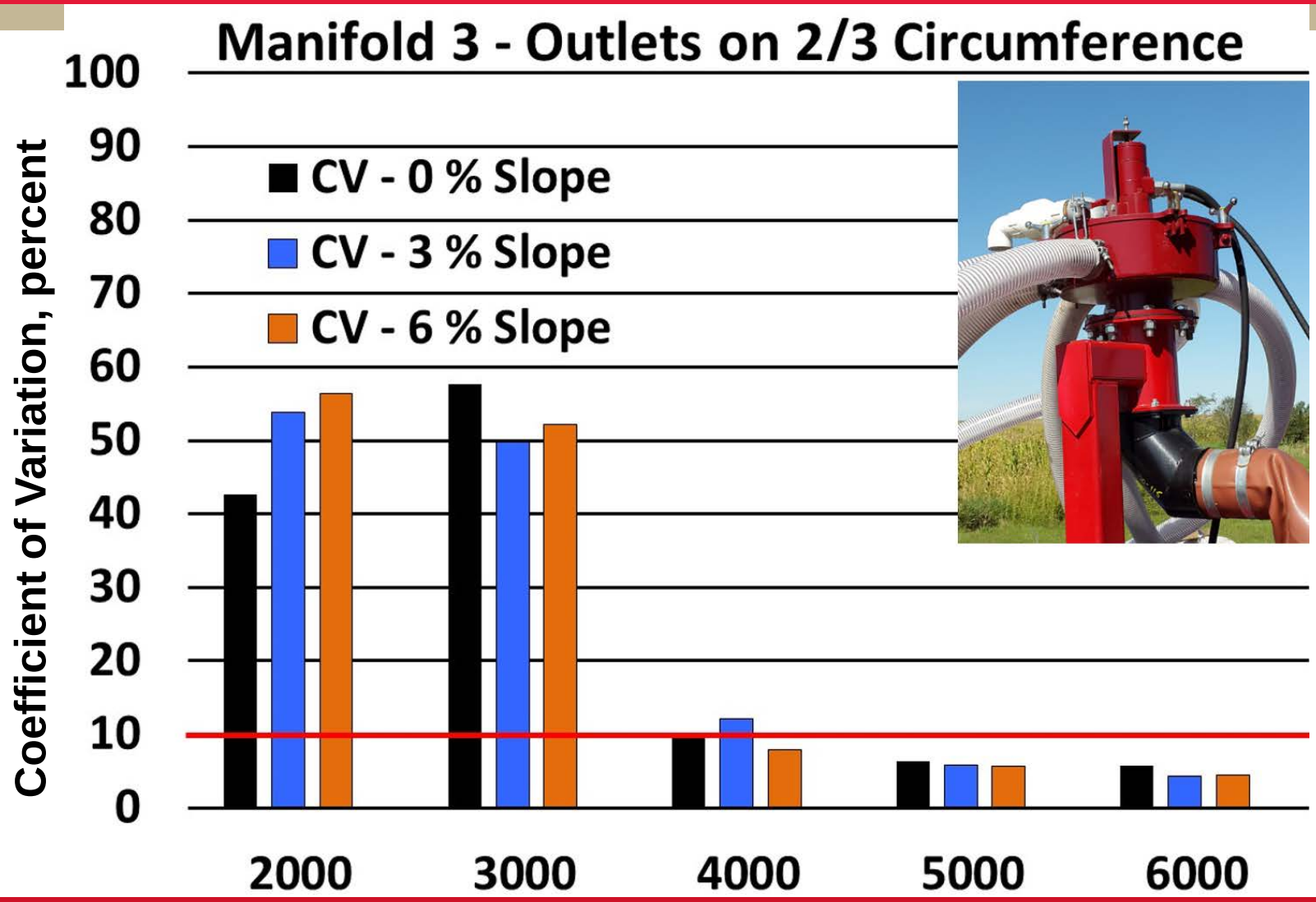
- Drive speed – 5 miles per hour
- Knife spacing – 30 inches
- Discharge hoses attached to a common beam for uniform collection
- 15 second time interval
- Slope setting of 0, 3, and 6 percent
- Uniform test methods across all measurements

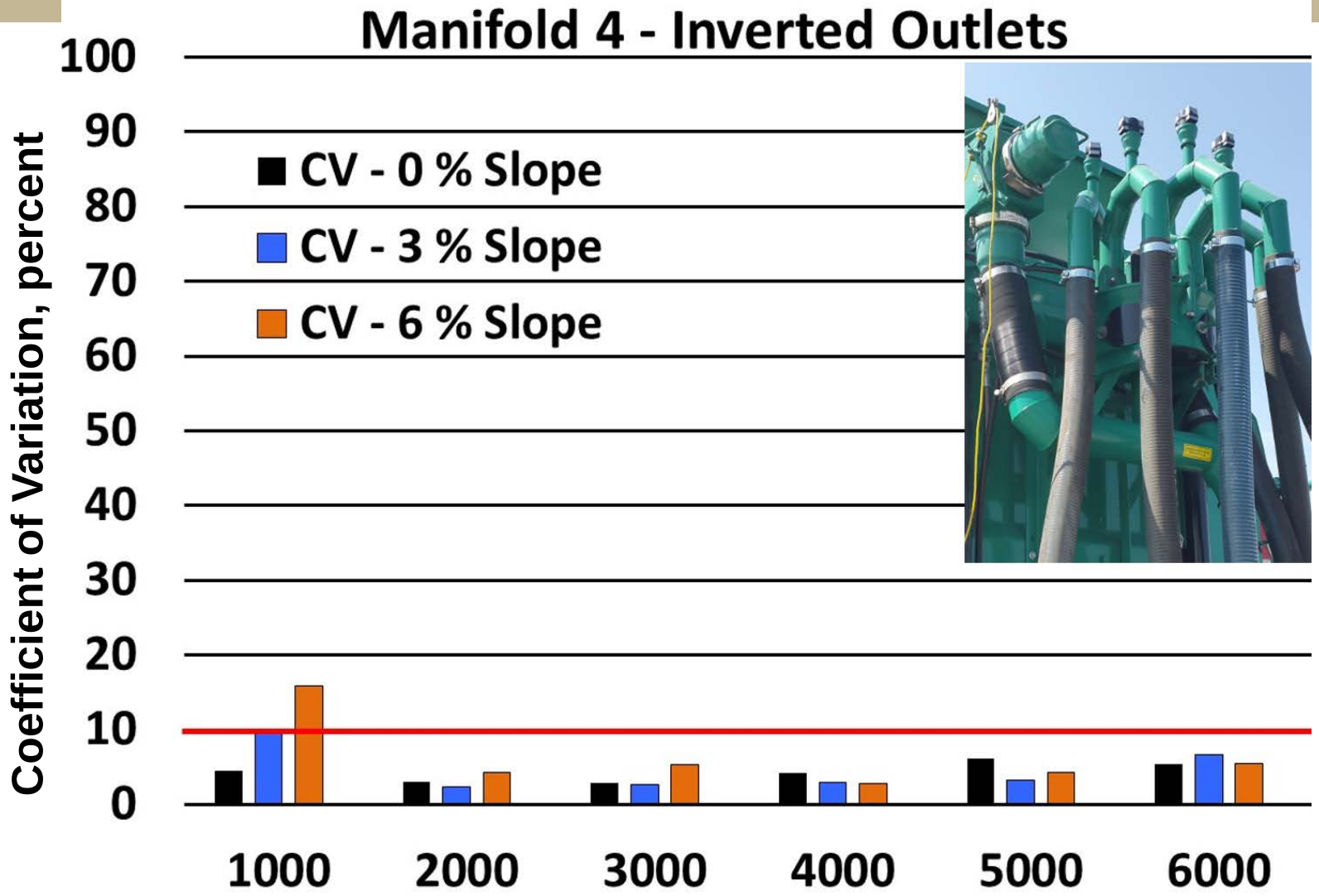
Manifold Testing Results

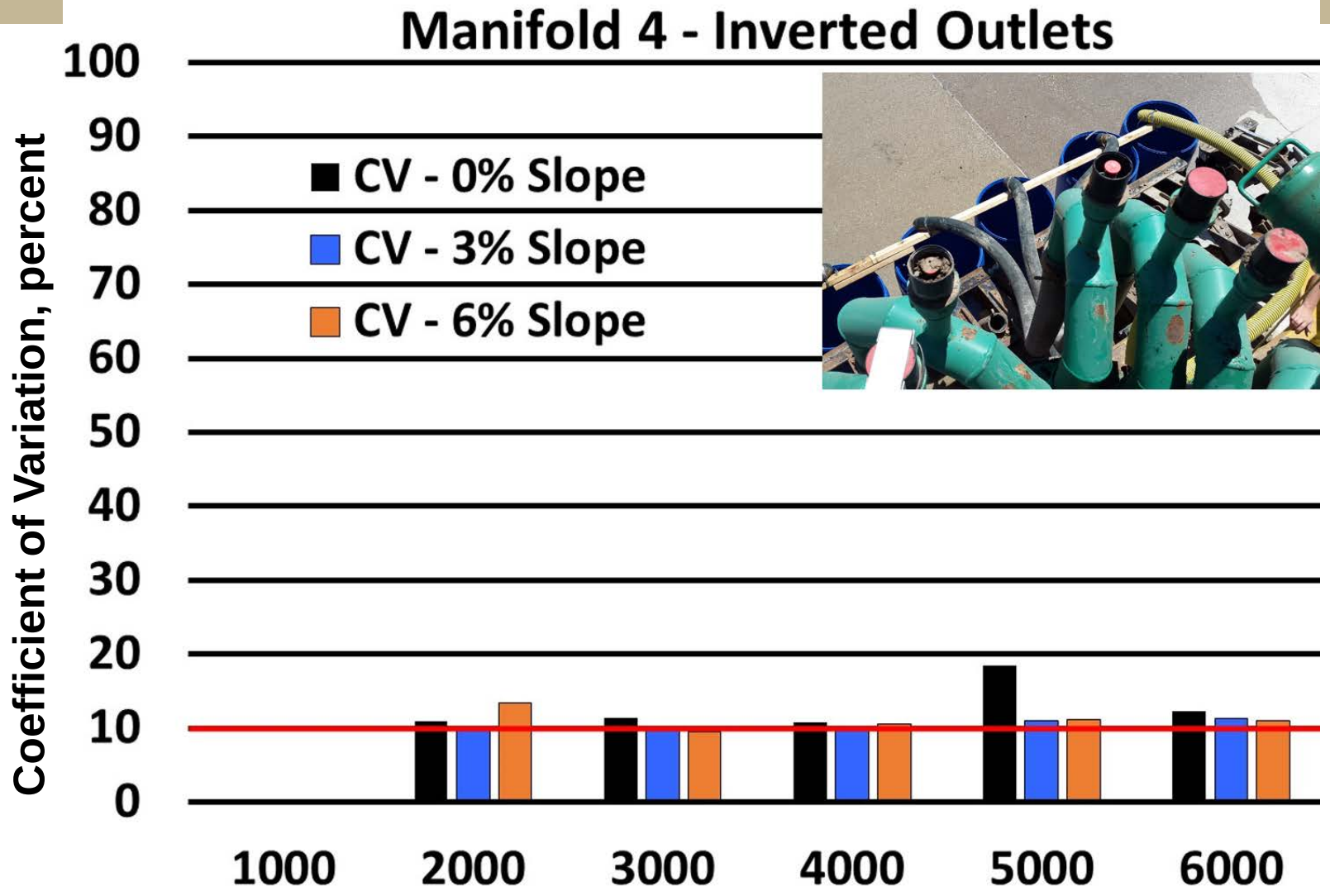
- Each manifold has different configuration
- Inlet size and location
- Manifold chamber size
- Outlet size, location, and number
- Each manifold has its own performance capabilities
- Some may be better suited for lower application rates while others for higher

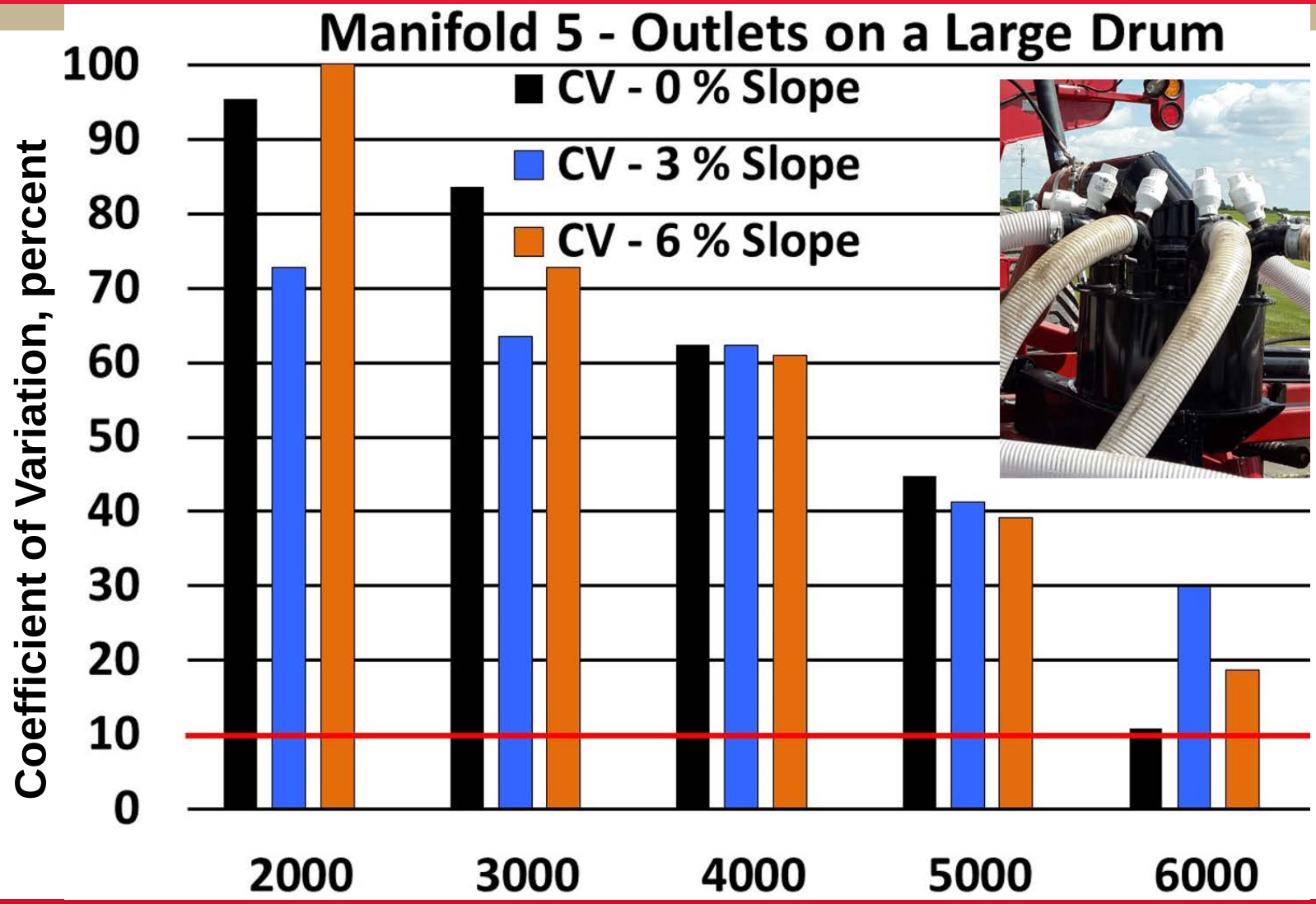

Manifold 1 - Crescent Moon
CV - 0 % Slope
CV - 3 % Slope
CV - 6 % Slope
Coefficient of Variation, percent
100
90
80
70
60
50
40
30
20
10
0
1000
2000
3000
4000
5000
6000
Application Rate, gallons per acre

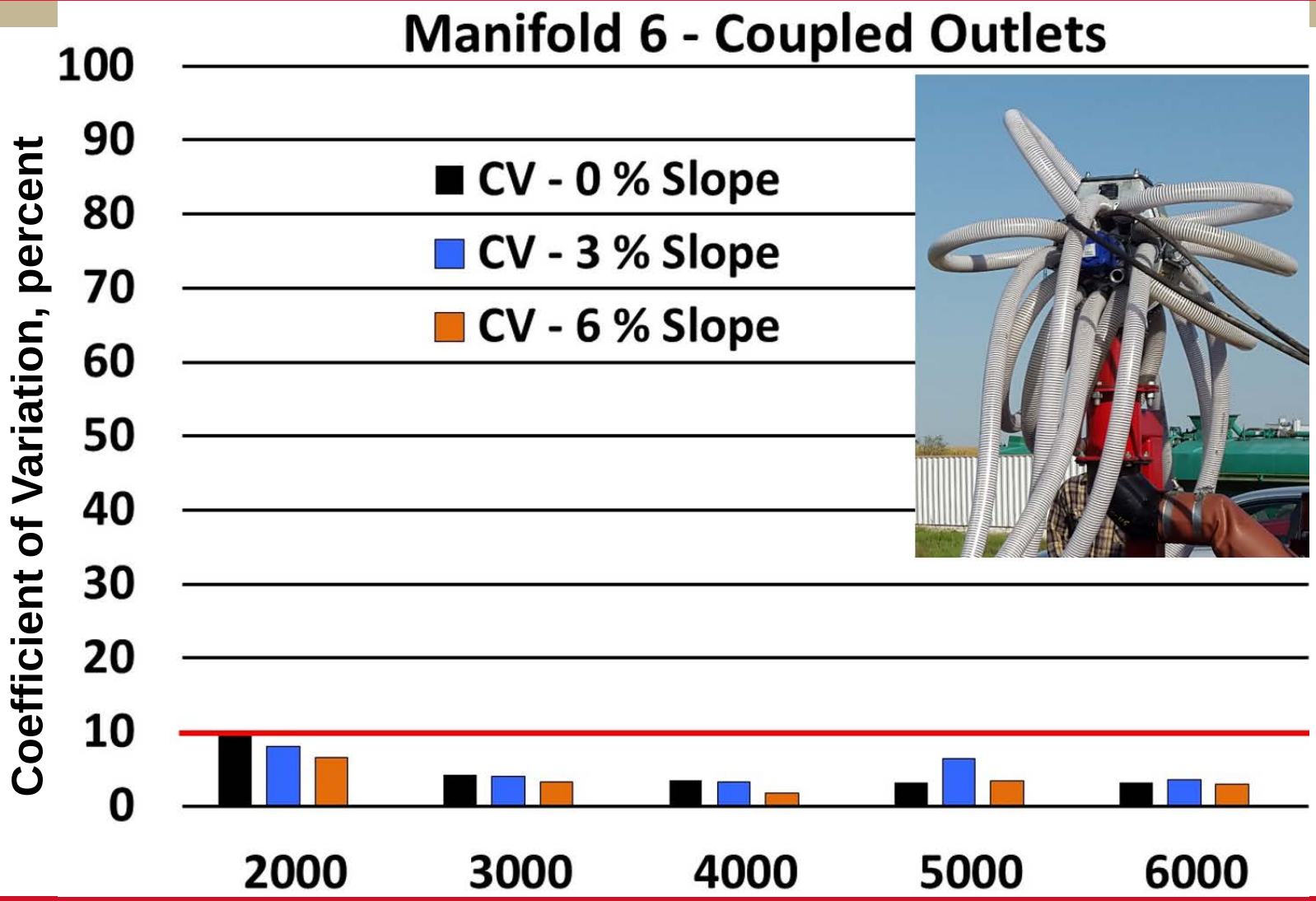

Manifold 2 - Outlets on Full Circumference
CV - 0 % Slope
CV - 3 % Slope
CV - 6 % Slope
Coefficient of Variation, percent
100
90
80
70
60
50
40
30
20
10
0
1000
2000
3000
4000
5000
6000
Application Rate, gallons per acre

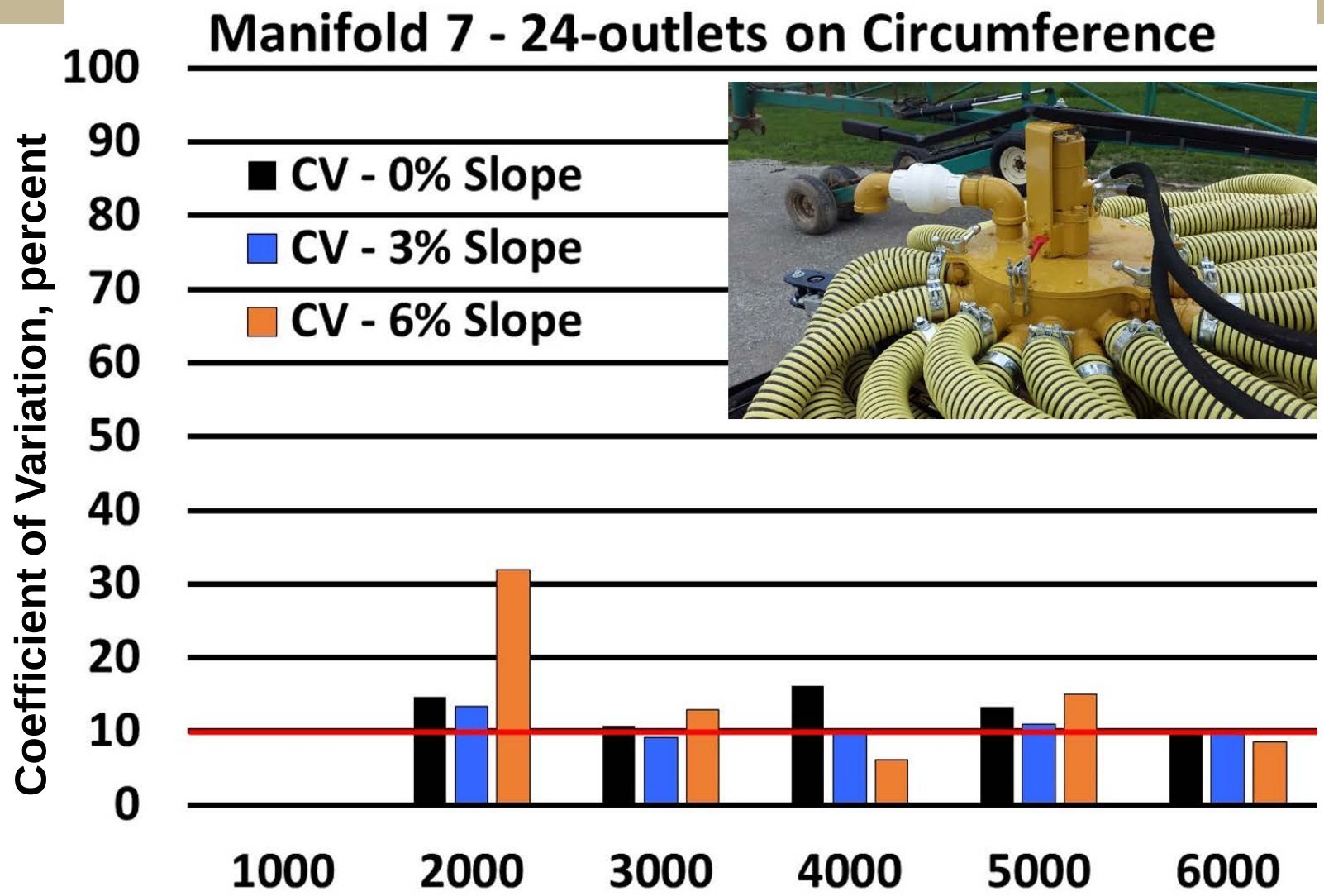

Manifold 3 - Outlets on 2/3 Circumference
CV - 0 % Slope
CV - 3 % Slope
CV - 6 % Slope
Coefficient of Variation, percent
100
90
80
70
60
50
40
30
20
10
0
2000
3000
4000
5000
6000
Application Rate, gallons per acre

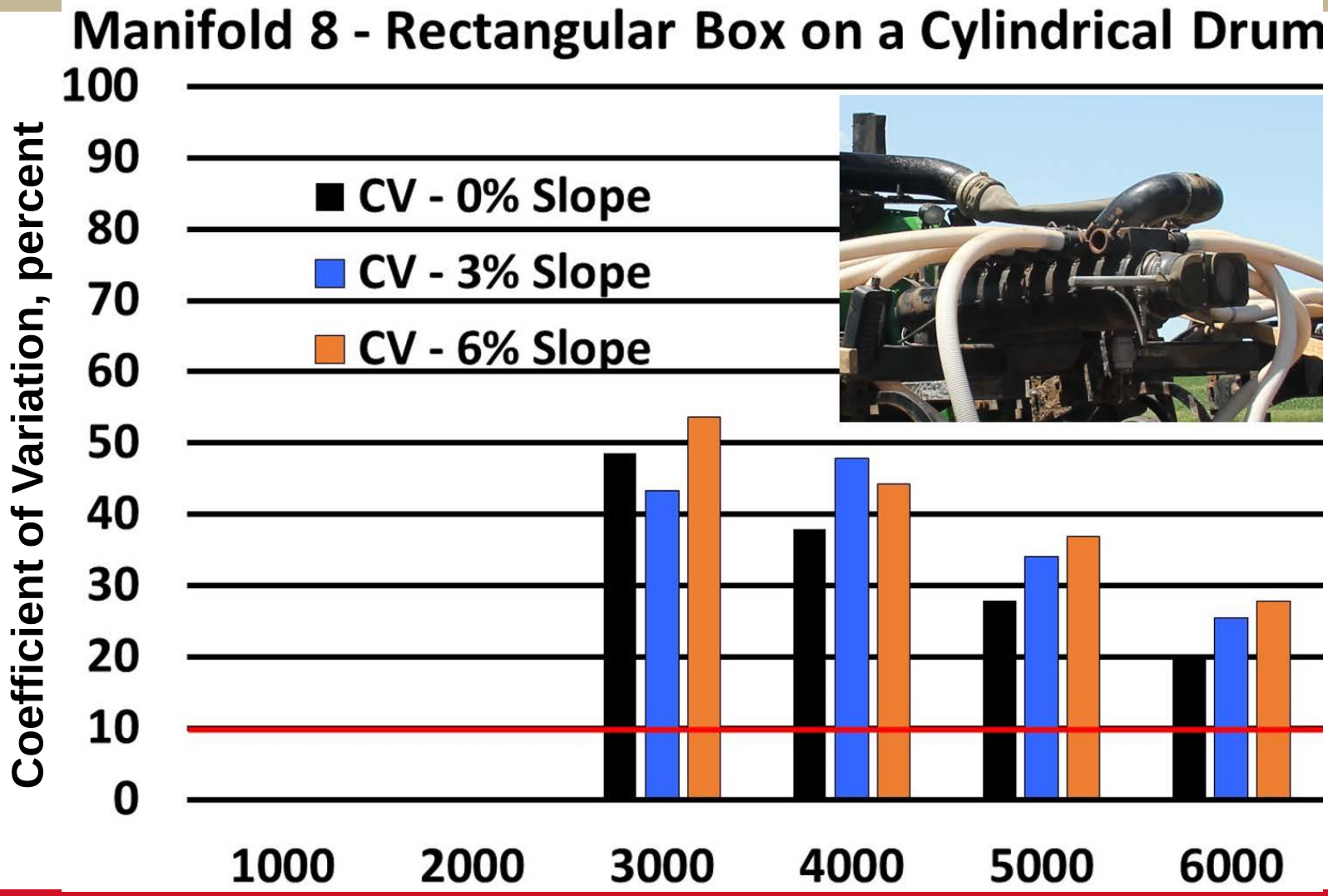

Manifold 4 - Inverted Outlets
Coefficient of Variation, percent
100
90
80
70
60
50
40
30
20
10
0
CV - 0 % Slope
CV - 3 % Slope
CV - 6 % Slope
1000
2000
3000
4000
5000
6000
Application Rate, gallons per acre

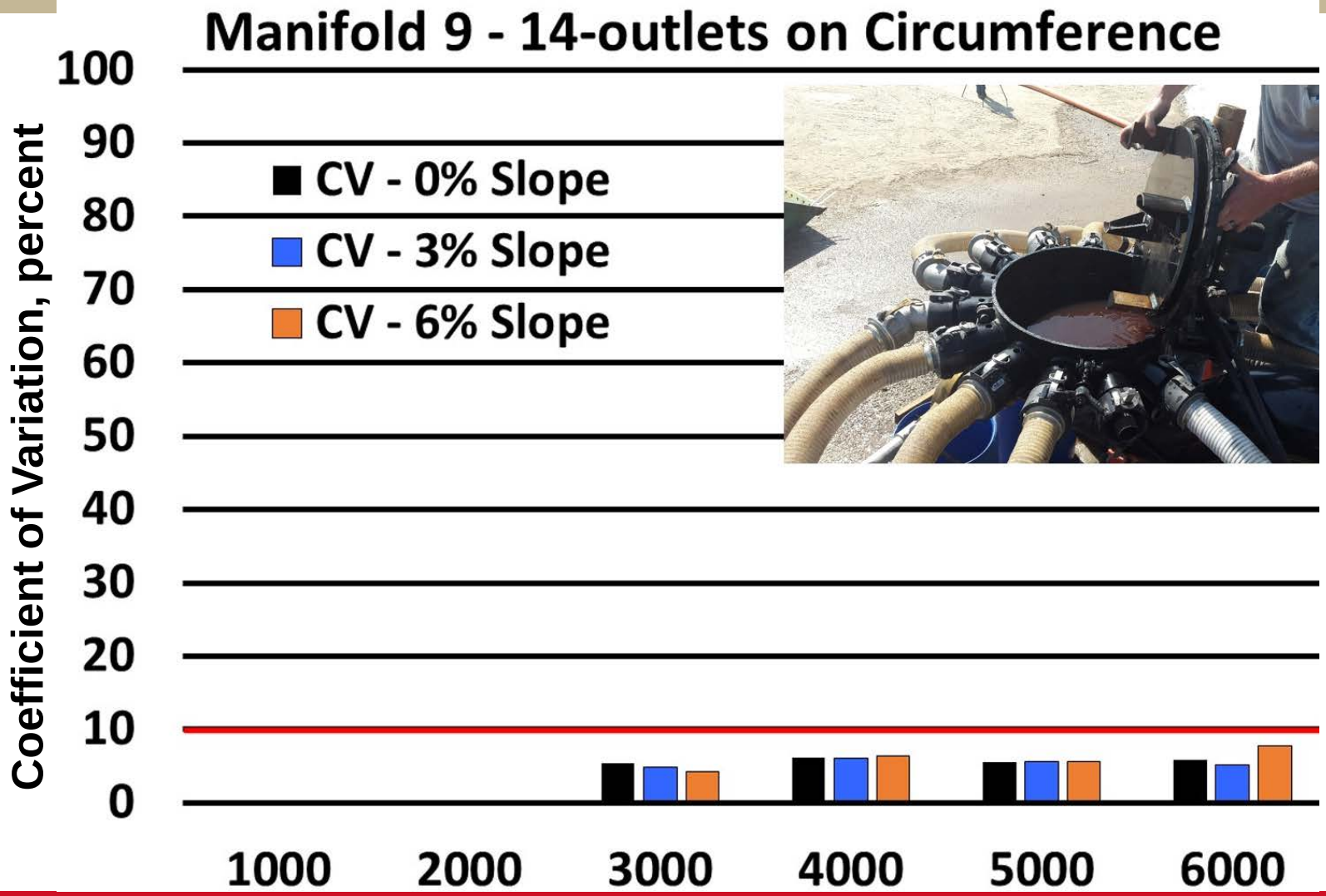

Manifold 4 - Inverted Outlets
CV - 0% Slope
CV - 3% Slope
CV - 6% Slope
Coefficient of Variation, percent
100
90
80
70
60
50
40
30
20
10
0
1000
2000
3000
4000
5000
6000
Application Rate, gallons per acre


Manifold 5 - Outlets on a Large Drum
CV - 0 % Slope
CV - 3 % Slope
CV - 6 % Slope
Coefficient of Variation, percent
100
90
80
70
60
50
40
30
20
10
0
2000
3000
4000
5000
6000
Application Rate, gallons per acre


Manifold 6 - Coupled Outlets
Coefficient of Variation, percent
100
90
80
70
60
50
40
30
20
10
0
CV - 0 % Slope
CV - 3 % Slope
CV - 6 % Slope
2000
3000
4000
5000
6000
Application Rate, gallons per acre


Manifold 7 - 24-outlets on Circumference
CV - 0% Slope
CV - 3% Slope
CV - 6% Slope
Coefficient of Variation, percent
100
90
80
70
60
50
40
30
20
10
0
1000
2000
3000
4000
5000
6000
Application Rate, gallons per acre


Manifold 8 - Rectangular Box on a Cylindrical Drum
Coefficient of Variation, percent
100
90
80
70
60
50
40
30
20
10
0
CV - 0% Slope
CV - 3% Slope
CV - 6% Slope
1000
2000
3000
4000
5000
6000
Application Rate, gallons per acre


Manifold 9 - 14-outlets on Circumference
CV - 0% Slope
CV - 3% Slope
CV - 6% Slope
Coefficient of Variation, percent
100
90
80
70
60
50
40
30
20
10
0
1000
2000
3000
4000
5000
6000
Application Rate, gallons per acre

Conclusions

- Caution to use results for high viscosity manures
- Two of the six tested manifolds produced coefficient of variation below 10% for all three slope settings at the average application rates of 2,000 to 6,000 gallons per acre
- Three additional manifolds produced coefficient of variation around 20% or lower for all three slope settings at the average application rates of 1,000 to 6,000 gallons per acre
- Caution should be exercised to select the appropriate manifold

Conclusions

- The results did not show a direct correlation between increase in slope and change in coefficient of variation. Change in slope did effect the coefficient of variation in case of certain manifolds.
- Eliminate any loops in the discharge hoses connected with the manifold outlets
- Any air vents provided on the manifold outlets need to be clean and functioning
- Coefficient of Variation can be managed to a certain extent by increase in drive speed or increasing knife spacing